

Mental health and adolescent Cannabis use

Susannah O'Brien and Wendy Swift

National Drug and Alcohol Research Centre
University of New South Wales

Report prepared for the New South Wales
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About the National Drug and Alcohol Research Centre

The National Drug and Alcohol Research Centre (NDARC) was established at the University of New South Wales in 1986. It is funded by the Australian Government Department of Health and Ageing as part of the National Drug Strategy. The Centre's mission is to contribute to a more effective and efficient Australian treatment system for alcohol and other drug related problems. The Centre is multidisciplinary and collaborates with medical, psychology, social science and other schools of the University and with other institutions and individuals in Australia and overseas. In addition to conducting national and international research, NDARC conducts an annual symposium, special conferences, workshops and seminars.

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Acknowledgement

This report was developed by the National Drug and Alcohol Research Centre (NDARC), University of New South Wales for the NSW Department of Education and Training. It is the third report on adolescent cannabis use produced for the NSW Department of Education and Training. The first report, *Educational outcomes and adolescent cannabis use*, was written by Lynskey and Hall (2000) and the current report has adopted a similar format. The influence of the work of Lynskey and Hall (2000) on the current report is gratefully acknowledged. NDARC acknowledge Wayne Hall and Louisa Degenhardt for providing comments on the report; Saul Gerber for providing references and Eva Congreve for library assistance.

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ISBN 0 7313 8390 7
SCIS 1208998

Graphic Design: BIAGDESIGN

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Executive summary

There has been recent public concern about possible relationships between adolescent cannabis use and mental health problems, such as depression and psychosis. These concerns may have been heightened by a marked increase in the prevalence of cannabis use among young people in Australia in recent decades and a dramatic increase in the suicide rate among young Australian males. By 2001 around one third of 14-19 year olds had used cannabis at least once and a quarter had done so in the past year.

Although experimentation is common in adolescence, young people who regularly use cannabis may risk negative effects at a time of rapid development and transitions in life roles. Of considerable concern is the trend among Australian adolescents and young adults to initiate cannabis use at a younger age. Adolescents who initiate cannabis use in the early teens are at higher risk of becoming dependent on cannabis, of using other illicit drugs and experiencing any adverse health effects of use as a consequence.

Cross-sectional surveys in the USA and Australia have found an association between regular cannabis use and a range of mental health problems, including psychosis, depression, anxiety and suicidal thoughts and behaviours in young people. There are three broad explanations for the relationship between cannabis use and poorer mental health. First, it may be that cannabis use is one of the causes of mental health problems. Second, mental health problems may increase the likelihood that young people will use cannabis. Third, cannabis use and mental health problems may not be directly related but rather the factors that increase the risk of using cannabis are the same as, or overlap with, the factors that increase the risks of mental health problems (e.g. social and environmental factors).

Cross-sectional surveys do not permit researchers to decide between these three explanations because it is not possible to determine what came first, the cannabis use or mental health problem. Furthermore, the contribution of other factors to cannabis use and mental health status can rarely be examined in this research design.

To distinguish between the explanations, it is necessary to have data from longitudinal studies in which large representative samples of young people are studied from childhood, before they begin using cannabis, into adult life. The young people are assessed at regular intervals over time on cannabis use and mental health status, as well as other factors that may affect the relationship (e.g. parental and family characteristics, personal characteristics and life experiences before using cannabis). These longitudinal studies enable researchers to assess the extent to which early cannabis use precedes, and is a risk factor for, mental health problems such as depression and psychosis. They also enable researchers to determine how much of the relationship between cannabis use and mental health problems is explained by the characteristics of children who are early initiators and regular users of cannabis. That is, researchers can begin to answer the question: do young people who use cannabis have poorer mental health than those who do not, when allowance is made for the fact that those who use cannabis regularly at a young age are more likely to experience life circumstances which increase their risk of poorer mental health?

Several recent large longitudinal studies have been conducted in Australia, New Zealand, the USA and other countries on the consequences of adolescent cannabis use. A number of these studies have assessed cannabis use and mental health status on a number of occasions over time, as well as factors on which cannabis users and non-users differ, such as demographic and family characteristics, in order to take these differences into account. These studies have used statistical methods to determine the extent to which prior cannabis use is associated with later mental health problems after the effects of confounding factors have been taken into account. These studies have generally shown that:

1. part of the association is explained by the characteristics of those who use cannabis at an early age, that is, young people who use cannabis in early adolescence are those who were at greatest risk of experiencing mental health problems and other adverse outcomes (e.g. doing poorly at school, displaying antisocial behaviour) before they began to use cannabis
2. not all of the association between cannabis use and these poorer outcomes can be explained in this way. Regular (especially daily) cannabis use appears to add to the risk of mental health problems among young people who are at risk for other reasons (e.g. psychological vulnerability, social disadvantage, affiliation with delinquent and substance-using peers, school drop-out and unemployment). It is yet to be resolved if, and to what extent, regular cannabis use increases the risk of mental health problems in adolescents who are not considered 'at risk' or psychologically vulnerable. Nevertheless, greater than weekly use among this age group is cause for concern.

A number of possible mechanisms have been hypothesised to explain why early cannabis use may increase the risk of poor mental health outcomes. One hypothesis is that daily cannabis use may cause changes in neurotransmitter systems in the brain that make mental health problems such as psychosis and depression more likely. It has been observed, for instance, that delta-9-tetrahydrocannabinol (THC) modifies dopamine transmission (the neurotransmitter considered to play an important role in psychotic disorders) and may therefore interact with a pre-existing genetically or environmentally determined vulnerability for dopaminergic system dysregulation. Exposure to cannabis, according to this hypothesis, may reveal or exacerbate pre-existing dysfunctions.

Another possibility is that the effects of regular or problematic cannabis use are socially mediated. That is, early cannabis use increases the chances of a young person adopting an unconventional lifestyle as a result of affiliating with delinquent and substance using peers and disengaging from conventional social roles such as completing education and obtaining a job. Research has supported the idea that cannabis use is associated with the premature adoption of adult roles by young people who are not equipped to fulfil them, with early cannabis users more likely to leave school early, leave the family home, more likely to engage in adolescent sexual activity and to experience unplanned pregnancy and teenage childbirth. The social consequences of regular cannabis use are all factors that may lead to higher rates of mental disorders. The acute effects of cannabis intoxication may also play a role by encouraging impulsive behaviour and impairing cognitive performance in the minority of young people who are daily cannabis users.

Conclusions and implications

The evidence increasingly suggests that regular, particularly daily, cannabis use adds to the existing risk of poor mental health and other adverse psychosocial outcomes in adolescents who are at risk for other reasons before they use cannabis. These effects most likely reflect a combination of factors. The social context of the peer group within which

cannabis is regularly used by early cannabis users encourages them to prematurely adopt adult roles they are not equipped to fulfil such as leaving school early, leaving the parental home and teenage pregnancy and childbirth. There may also be direct pharmacological effects of cannabis which may place people who are vulnerable to developing mental disorders such as psychosis, at particular risk of developing symptoms and perhaps of developing lasting disorders.

Given the serious consequences of mental health problems in young people on their life choices and chances, it is important to intervene to reduce or ameliorate the effects of early cannabis use on mental health. This will require a mix of strategies. These include providing additional support to children and adolescents whose poor mental health puts them at risk of early cannabis use; broader-based early interventions for the families of children and adolescents who are at risk of a variety of adverse personal and social outcomes; education about the risks of poor mental health and other adverse outcomes as part of health education about drugs; and early intervention approaches for adolescents who use cannabis, especially those who initiate use in early adolescence and those who use more than weekly.

1 Introduction

Cannabis is the most widely used illicit drug among young Australians. In 2001, 34% of a national household sample of adolescents aged 14-19 years reported that they had used cannabis at some time in their lives and 25% reported use in the last year (Australian Institute of Health and Welfare, 2002a).

Cannabis is typically first used in adolescence (Chen and Kandel, 1995), an important time of transition between childhood and adulthood. The mental wellbeing of an adolescent is an important determinant of how well this transition is negotiated and will affect an individual's options and choices in life at that time and in the future. Cannabis use is widespread among Australian adolescents and its short-term effects include impairment of thinking, memory and psychomotor performance (Hall and Solowij, 1998; Hall, Degenhardt and Lynskey, 2001). While there are many determinants of mental health problems¹, it is understandable that many parents and teachers are concerned about whether cannabis use in adolescence adversely affects mental health, precipitating for example, depression, anxiety or psychosis. These concerns may have been heightened given the fact that in recent decades there has been a marked increase in the prevalence of cannabis use among young people in Australia (Hall and Pacula, 2003) and a dramatic increase in the suicide rate among young Australian males (Lynskey, Degenhardt and Hall, 2000).

The potential adverse effects of cannabis use on mental health are not the only source of parental concern about adolescent cannabis use. Parents are also concerned about the extent to which cannabis may be a 'gateway' drug, that is, whether adolescents are more likely to use other illicit drugs such as amphetamines, cocaine and heroin as a result of using cannabis (Hall, Degenhardt and Lynskey, 2001). There are also concerns about whether adolescents can become dependent on cannabis and whether cannabis use in adolescence has adverse effects on outcomes such as educational achievement, employment and involvement in crime.

An increasing body of research is examining the background to, and consequences of, adolescent cannabis use. Our focus in this report is the relationship between adolescent cannabis use and mental health problems. Anxiety, depression, suicide and psychosis are among the most prevalent behavioural/emotional problems experienced by adolescents and/or the most often linked to cannabis use.

¹ Mental health problems manifest as disturbances that affect a person's thoughts, feelings and behaviour. If these disturbances are associated with distress (e.g. a painful symptom) or impairment in one or more important areas of functioning or with an increased risk of suffering death, pain, disability or an important loss of freedom, a mental health disorder may be identified. Mental health disorders are typically diagnosed using one of two major classification systems: the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) (2000) or the World Health Organisation's International Classification of Disease, Tenth revision (ICD-10) (1993). Note, the terms 'mental health problems' and 'mental health disorders' have been used interchangeably in this review.

When the term ‘mental health problem’ is used in this review it does not extend to the externalising disorders² of conduct disorder, oppositional defiant disorder and attention deficit hyperactivity disorder (ADHD), which were not reviewed due to the limited nature of the research available examining cannabis use specifically.

A brief summary of the evidence on the gateway hypothesis and educational outcomes, as well as a definition of cannabis dependence is provided in the Appendices, along with suggestions for further reading. A comprehensive review of adolescent cannabis use and educational outcomes can be found in Lynskey and Hall (2000), an earlier report produced in this series for the NSW Department of Education and Training. For a complete summary of the research on the effects of cannabis on adolescent development, including educational performance, mental health, employment and crime, refer to Hall and Pacula (2003).

This report summarises the research findings on the effects of cannabis use on mental health³. Its specific aims are to:

- describe the patterns of cannabis use among young Australians
- summarise the research on the association between cannabis use and mental health problems
- summarise the research on the most plausible explanations of the association between cannabis use and mental health problems (e.g. does one cause the other?)
- identify some of the implications of these research findings for intervention and further research.

² Externalising disorders manifest as behavioral disturbances linked to lack of control, such as conduct disorder or attention deficit hyperactivity disorder (ADHD). This cluster of problems are characterized by behaviours directed outward (e.g. temper tantrums, overactivity, aggression, delinquency), typically toward other people. In contrast, internalising disorders manifest within the self as disturbances of mood such as depression or anxiety disorders (Achenbach and Edelbrock, 1978). For further reading on the relationship between cannabis use and externalising problems and behaviours see Pedersen, Mastekaasa and Wichstrom, 2001; Arseneault, Moffitt, Caspi, Taylor and Silva, 2000; Fergusson, Lynskey and Horwood, 1993.

³ This report was written in 2004 and is based on the most recent information available at that time.

2 Patterns of cannabis use

2.1 Cannabis the drug

Cannabis preparations come from the plant *Cannabis sativa*. The constituent of the plant that is primarily responsible for the psychoactive effects sought by cannabis users is known as delta-9-tetrahydrocannabinol or THC (Gaoni and Mechoulam, 1964; Martin and Cone, 1999; Iversen, 2000). THC is primarily found in the resin that covers the flowering tops and upper leaves (Clarke and Watson, 2002).

The most common cannabis preparations are marijuana, hashish and hash oil. Marijuana is prepared from the dried flowering tops and leaves of the plant and has a typical THC content ranging from approximately 1% to 4%. Hashish, or hash, consists of dried cannabis resin and contains a greater level of THC, with potency typically ranging between 2% and 8% THC. Hash oil is the strongest product and may contain on average between 9% and 23% THC (ElSohly, Ross, Mehmedic, Arafat, Yi and Banahan, 2000; Poulsen and Sutherland, 2000). There has probably been a modest increase in the THC content of cannabis in recent decades but, contrary to media reports, there is no published Australian evidence to support claims it has increased thirty-fold (Hall and Swift, 2000). A recently expressed concern is that the common use of hydroponic cannabis is associated with an increase in the experience of psychotic symptoms, particularly among young people. Anecdotal reports claim this is due to the high potency of this product. However, while there is limited published evidence that hydroponic cannabis may have slightly higher THC levels than cannabis grown outdoors, there is currently no research evidence to link the use of hydroponic cannabis specifically with such symptoms. It is true, however, that the more potent parts of the plant, such as the 'heads', are now more widely used, particularly by young people (Hall and Swift, 2000).

Cannabis is typically smoked. Among younger users, a water pipe or 'bong' is the most common way of smoking all cannabis preparations (Reid, Lynskey and Copeland, 2000). Cannabis may also be smoked in a cigarette or 'joint' that may include tobacco to assist burning (Hall and Pacula, 2003). Typically, smokers will inhale deeply and hold their breath to ensure maximum absorption of THC by the lungs. Cannabis preparations can also be eaten but Australian surveys indicate that most users smoke the drug (Reid et al, 2000). This is probably because smoking is the most efficient way of delivering THC to the brain (Martin and Cone, 1999) and it is easier to regulate the desired dose by smoking.

2.2 The effects of cannabis

THC acts on brain receptors known as 'cannabinoid receptors', which are also acted upon by substances that occur naturally in the brain ('endogenous cannabinoids') and mimic the action of THC (Devane, Hanus, Breuser, Pertwee, Stevenson, Griffin, Gibson, Mandelbaum, Etinger and Mechoulam, 1992; Stella, Schweitzer and Piomelli, 1997). Cannabinoid receptors are found in brain regions involved in the control of mood, memory and motor performance, all of which are affected by cannabis (Ameri, 1999).

The main reason why most young people use cannabis is to experience an altered state of consciousness or a 'high'. This 'high' is characterised by mild euphoria, relaxation and perceptual alterations, including time distortion and intensification of experiences such as eating, watching films, listening to music and engaging in sex (Tart, 1970; Jaffe, 1985). In a social setting, the 'high' may be accompanied by infectious laughter, talkativeness and increased sociability (Hall and Pacula, 2003). In a survey of 100 Australian cannabis-using adolescents aged 15-19 years, more than one third reported using cannabis because it helped them to relax, and relieved stress and negative emotions (38%) and because it was fun, enjoyable and made them happy (34%). Approximately one in five adolescents surveyed used cannabis because of curiosity or to relieve boredom (Copeland, Swift, Clement and Reid, 2001).

Changes in brain functioning when 'high' include impaired short-term memory and attention that make it easy for the user to become lost in pleasant daydreams but difficult to sustain goal-directed mental activity (Solowij, 1998). Motor skills, reaction time, motor coordination and therefore many forms of skilled activity are also impaired while the user is intoxicated (Jaffe, 1985). There is now some evidence that driving after using cannabis increases the risk of motor vehicle accidents, especially when it is used with alcohol (Mura, Kintz, Ludes, Gaulier, Marquet, Martin-Dupont, Vincent, Kaddour, Gouille, Nouveau, Moulisma, Tilhet-Coartet and Pourrat, 2003; Fergusson and Horwood, 2001a).

Some users report unpleasant experiences after using cannabis, including anxiety, panic, fear of going mad and depression (Smith, 1968; Weil, 1970; Thomas, 1993; Thomas, 1996). These are often reported by inexperienced users (Weil, 1970) but may be reported by more experienced users if they use a much larger dose than usual. Psychotic symptoms such as delusions and hallucinations are uncommon but may occur at very high doses of THC and perhaps in susceptible individuals at lower doses (Smith, 1968; Weil, 1970; Thomas, 1993) (see Sections 4.1.1 and 4.1.2).

No deaths directly attributed to cannabis have been definitively reported in the medical literature; fatal overdoses are unlikely to occur as the dose required would be difficult for users to take (Hall and Pacula, 2003).

2.3 The prevalence of cannabis use among young Australians

Data from the 2001 National Drug Strategy (NDS) Household Survey indicate approximately one third (34.3%) of 14-19 year olds have ever tried cannabis and approximately one quarter (24.6%) have used recently (in the last year) (Australian Institute of Health and Welfare, 2002a). As shown in Table 1 the prevalence of lifetime cannabis use increased with age from 17% among 14-15 year olds to 47% among 18-19 year olds. Use within the last year also increased with age from 15% among 14-15 year olds to 32% among 18-19 year olds. Overall, males were more likely to report cannabis use than females: 35% and 27% of all males aged 14-19 years reported lifetime cannabis use and use in the last year respectively, compared with 33% and 23% of females (Cid Mateo, Australian Institute of Health and Welfare (AIHW), personal communication, 2003). However, slightly more females than males aged 14-15 years reported ever using cannabis and use in the last 12 months.

Table 1: Prevalence (%) of cannabis use among males and females aged 14-19 years by age, Australia, 2001

Age	Ever Used			Used in the last 12 months		
	Males	Females	Total	Males	Females	Total
14-15	16	19	17	13	17	15
16-17	38	34	36	28	23	26
18-19	50	44	47	37	27	32
14-19	35	33	34	27	23	25

Source: National Drug Strategy Household Survey 2001.

Table 2 presents data on the frequency of cannabis use among the 25% of males and females who reported using cannabis in the last 12 months. It shows that most of the young people who had used cannabis in the past year used it less than weekly. There was a trend toward increased rates of weekly or greater use with age, increasing from 29% among 14-15 year olds to 32% among 18-19 year olds. Overall, 35% of young males and 25% of young females who reported recent use were smoking cannabis at least weekly. Young males typically report more frequent and heavier use than females (Hall, Degenhardt and Lynskey, 2001; von Sydow, Lieb, Pfister, Hofler and Wittchen, 2002), although not all studies have found such gender differences (e.g. Perkonig, Lieb, Hofler, Schuster, Sonntag and Wittchen, 1999). Looking at Table 2 it can be seen that among recent users, more females than males aged 14-15 years reported smoking on a weekly or greater basis. These data are in line with reports that sex differences in rates of cannabis and other drug use are narrowing as young women increasingly adopt patterns of use that mirror those of their male counterparts (Perkonig et al, 1999). This may also reflect cannabis use becoming more socially acceptable and destigmatised (Rey, Sawyer, Raphael, Patton and Lynskey, 2002).

Table 2: Frequency of cannabis use (%) among males and females aged 14-19 years using cannabis in the last 12 months by age, Australia, 2001

Age	Once a week or more			Less often		
	Males	Females	Total	Males	Females	Total
14-15	22	34	29	78	66	71
16-17	36	21	30	64	79	70
18-19	39	24	32	61	76	68
14-19	35	25	31	65	75	69

Source: National Drug Strategy Household Survey 2001.

The rates of use of other illicit drugs, including heroin, hallucinogens, inhalants, ecstasy, amphetamine and cocaine, were all substantially lower than those for cannabis among this age group (all < 10%) (Australian Institute of Health and Welfare, 2002b).

2.4 Comparisons with previous studies

It is difficult to compare the results of the latest NDS household survey to the 1998 NDS survey due to wording differences between the two surveys. Bearing this in mind, the latest NDS household survey data appear to reflect a slight but significant decrease in use among young Australians since the 1998 survey – among 14-19 year olds in the 1998 survey, just under half (44.6%) reported using cannabis at some time in their lives and a

third (34.6%) in the past year (Australian Institute of Health and Welfare, 1999). In any case, cannabis use among secondary students remains common. Data from the 2002 Australian School Students' Alcohol and Drugs (ASSAD) Survey of 12-17 years olds, confirm the widespread use of cannabis among secondary students, particularly males and older students (White and Hayman, 2004), with 25% of students using cannabis at some time in their lives.

The 1996 ASSAD Survey found that 36% of students aged 12-17 had ever used cannabis (Lynskey and Hall, 1999). Earlier studies among school aged youth in various Australian states conducted in the early 1990s reported rates of cannabis use between 25% and 30% (Donnelly and Hall, 1994). The 1996 school survey results suggested that there was an increase in the use of cannabis among youth during the early 1990s, a finding that is supported by the NDS Household Surveys over that time. The latest ASSAD data suggest a slight decrease in use in the late 1990s and early 2000s, with the percentage of students aged 12-17 years using cannabis at some time in their lives falling from 29% in 1999 to 25% in 2002 (White and Hayman, 2004).

Perhaps of greater importance is the major trend among Australian adolescents and young adults to initiate cannabis use at a younger age. In the 1998 NDS Household Survey, one in five cannabis users (21%) born between 1940 and 1949 had initiated cannabis use by age 18, compared to 43% of those born in 1950-59, 66% of those born 1960-69 and 78% of those born in 1970-79 (Degenhardt, Lynskey and Hall, 2000). The average age of first use among Australian 14-19 year olds in 2001 was 14.7 years (Cid Mateo, AIHW, personal communication, 2003).

Earlier initiation of cannabis use increases the chances that these young people will become daily or near daily cannabis users (Fergusson and Horwood, 1997; Kandel and Davies, 1992). This, in turn, increases the risks of becoming dependent on cannabis and experiencing the adverse personal and social consequences of such use (Dennis, Babor, Roebuck and Donaldson, 2002; Swift, Hall and Teesson, 2001a). Regular cannabis use also makes users tolerant to the effects of THC, possibly encouraging the use of more potent cannabis preparations (Hall and Swift, 2000).

2.5 Comparisons between Australia and other countries

It is of interest to compare the prevalence of cannabis use among Australian youth with the corresponding prevalence estimates from other countries. The most comprehensive information on cannabis use has been collected in the United States of America (USA). The 'Monitoring the Future' project has surveyed approximately 15,000 high school seniors since 1975 (Johnston, O'Malley and Bachman, 2003). Since 1991 national samples of Grade 8 and Grade 10 students have also been surveyed annually.

In the 2001 survey, lifetime cannabis use increased with grade, from 20.4% among Grade 8 to 48.9% among Grade 12 students (Johnston, O'Malley and Bachman, 2002a). The same increases by grade were evident for use during the past year and past month. Keeping in mind that the methods of sampling and data collection are not identical in the two surveys, a comparison of Australian data from the 1999 ASSAD Survey (White, 2001) with the 1999 'Monitoring the Future' data (Johnston, O'Malley and Bachman, 2002a) indicates that the prevalence of cannabis use among Australian and American youth is similar (see Table 3). The same can be said of the 2001 'Monitoring the Future' data which are similar to 1999 data.

Table 3: Comparison of the lifetime cannabis use percentage among Australian and American (USA) youth⁴

	Australia	USA
Grade 8/13 years	17.0	22.0
Grade 10/15 years	38.3	40.9
Grade 12/17 years	49.6	49.7

The rise in prevalence of cannabis use among Australian youth during the 1990s, discussed above, has been paralleled by similar trends in the USA. In the USA, after a considerable increase in the 1990s, the lifetime prevalence rates of cannabis use peaked in 1996 among Grade 8 students at 23.1%, in 1997 among Grade 10 students at 42.3% and in 1999 among Grade 12 students at 49.7% (Johnston, O'Malley and Bachman, 2002a). In line with Australian data, there has been some decline since those peak levels, more so among the Grade 8 students, but no one-year change was significant in either 2000 or 2001 (Johnston, O'Malley and Bachman, 2002b).

Data from New Zealand's 2001 National Drug Survey show similar rates of cannabis use among young people to Australia. Approximately one third (34.8%) of 15-17 years olds have ever tried cannabis and just over a quarter (28.8%) have used it in the last year. Females in this age group were slightly more likely to report cannabis use than males: 38% of females reported lifetime cannabis use compared with 32.6% of males. They were also more likely to report use in the last year, with 30% of females using in the past year compared to 28% of males (Wilkins, Casswell, Bhatta and Pledger, 2002). Lifetime use among females aged 15-17 years increased from 26% in 1998 to 38% in 2001, as did use in the last year from 20% to 30%.

2.6 Cannabis dependence

As outlined in the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) (2000), drug dependence, including cannabis dependence, comprises a cluster of symptoms indicating that an individual continues to use the drug despite significant related problems (see Appendix 2 for a complete description).

Chronic cannabis use produces tolerance, some users report withdrawal symptoms on cessation of use and there is evidence that heavy cannabis users experience problems controlling their cannabis use and continue to use despite experiencing adverse consequences of use (Swift, Hall and Copeland, 1998a; Swift, Hall, Didcott and Reilly, 1998b; Swift, Hall and Teesson, 2001b). In Australia and the USA cannabis dependence is the most common form of drug dependence after alcohol and tobacco (Swift, Hall and Teesson, 2001a; Anthony, Warner and Kessler, 1994).

Based on research primarily among adults, the risk of developing cannabis dependence is about one in ten among those who ever use the drug; between one in five and one in three among those who use cannabis more than a few times; and approximately one in

⁴ It should be noted that the USA data are tabulated by school grade whereas the Australian data have been presented by student age. In making the comparison in Table 3, the method used by Lynskey and Hall (2000) was adopted, where the USA Grade 8 data have been compared with 13 year old Australians, the USA Grade 10 data have been compared with 15 year old Australians and the USA Grade 12 data have been compared with 17 year old Australians. The comparison should be treated with a degree of caution given these methodological differences.

two among those who become daily users (Hall and Pacula, 2003). Young people may be more likely to develop cannabis dependence than adults, possibly because of an increased susceptibility to dependence or the impact of age-associated effects, for example, the over-reporting of the features of cannabis dependence by younger users or the fact that use was not common in Australia until the 1970s (e.g. Dennis et al, 2002; Swift, Hall and Teesson, 2001a; Chen and Anthony, 2003). In general population studies of young people, the prevalence of cannabis dependence increases throughout adolescence, up to levels of 10% among young adults (e.g. Coffey, Carlin, Degenhardt, Lynskey, Sanci and Patton, 2002; Fergusson and Horwood, 2000).

In summary, data from the most recent ASSAD and NDS surveys indicate that cannabis use is widespread among Australian adolescents, particularly boys, with approximately three in every ten young people reporting having used cannabis. Comparisons of surveys across time suggest that there was an increase in cannabis use among Australian youth during the early 1990s. Latest Australian data suggests a slight decrease in use since the late 1990s. Of considerable concern is the trend among Australian adolescents and young adults to initiate cannabis use at a younger age. Earlier involvement with cannabis increases the risks of becoming cannabis dependent and experiencing the adverse health effects as a consequence.

3.1 The mental health of young Australians

Transition from childhood to adulthood undoubtedly brings adjustments to physical maturity, changing roles within families and with peers and the emergence of a more independent lifestyle. Most young people negotiate these changes without major upheaval. However, approximately one in five adolescents appears to encounter a more prolonged phase of emotional difficulties in which experiences of depression and anxiety are common (Offer and Schonert-Reichl, 1992).

Data from the 2000 Child and Adolescent Component of the Australian National Survey of Mental Health and Well-Being (NSMHWB) showed that 19% of Australian adolescents (aged 13-17 years) scored in the clinical range (i.e. the range typically reported for adolescents attending mental health clinics) on a self-report instrument identifying mental health problems. Specifically, 12% of adolescents scored in the clinical range on the Delinquent Behaviour scale, 8% on the Aggressive Behaviour scale, 7% on the Attention Problems scale and 7% on the Anxious/Depressed scale. Adolescents with more emotional and behavioural problems reported lower self-esteem, more problems with their physical health and greater difficulty with school and peer activities. They also reported a high rate of other health-risk behaviour, including smoking, drinking and cannabis use (Sawyer, Arney, Baghurst, Clark, Graetz, Kosky, Nurcombe, Patton, Prior, Raphael, Rey, Whaites and Zubrick, 2000).

In recent decades there has been a general rise in the rates of many mental health disorders among youth (Rutter, 1999) including affective disorders (i.e. disorders involving a major disturbance of emotions), such as depression (Cross National Collaborative Group, 1992; Fombonne, 1995), antisocial behaviours (Smith, 1995) and misuse of drugs and alcohol (Hall, Degenhardt and Lynskey, 1999). Much of the evidence of rising rates of mental health disorders among youth is derived from overseas studies. However, given the broad similarities in many of the social conditions in Australia and these countries, coupled with local evidence of rising rates of substance use (Hall, Degenhardt and Lynskey, 1999), it seems reasonable to conclude that rates of mental health problems among Australian youth have risen in the past 50 years.

3.2 Adolescent suicide rates

Suicide is a major cause of death among young Australians aged 15-24, second only to motor vehicle accidents in the proportion of deaths it causes (Lynskey et al, 2000). Current research evidence suggests that mental health problems, in particular, affective disorders (such as depression), substance use disorders (abuse or dependency) and antisocial behaviours are the strongest risk factors for youth suicide (Beautrais, 2000). Consistent with this research, the Child and Adolescent component of the NSMHWB found a strong association between adolescent mental health problems and suicidal behaviour and ideation (Sawyer et al, 2000). Australian adolescents having mental health problems were 4.8 times (95% Confidence Interval (CI) = 3.0 to 7.6) more likely to have seriously considered attempting suicide, 10.4 times (95% CI = 5.2 to 21.0) more likely to

have actually attempted suicide and 5.2 times more likely to have made a suicide attempt requiring treatment (95% CI = 1.2 to 23.5) than adolescents not having mental health problems (i.e. those who scored in the non-clinical range) (Sawyer, Arney, Baghurst, Clark, Graetz, Kosky, Nurcombe, Patton, Prior, Raphael, Rey, Whaites and Zubrick, 2001).

In summary, a general rise in the rates of many mental health problems and a dramatic increase in the suicide rate among young males have occurred at the same time as an increase in the prevalence of cannabis use among young people. These findings have probably served to increase parental and public concerns over the links between cannabis use and mental health problems. Is there an association between cannabis use and mental health problems and if so, what is the association? The focus of the next section of this review is to address these questions.

4

Cannabis use and mental health—describing the association

A number of cross-sectional studies, which assess the health status and risk factors of a sample at one point in time (e.g. a survey) have examined associations between cannabis use and aspects of mental health. In order to minimise the effects of selection bias, which occurs when the apparent effects of cannabis can be attributed to the pre-existing characteristics of the people studied rather than the use of the drug, it is best to study the patterns of these associations in representative samples of the general population. Studies of specific populations (e.g. college students, commune dwellers) and studies that did not compare cannabis users with non-users were not reviewed in this report, as it would be difficult to generalise the finding of these studies to the general population. Studies that grouped cannabis with other drugs were also typically excluded as it would not be clear whether the patterns found for ‘drug abuse/dependence’ would be the same as for cannabis alone. Unfortunately, most of these cross-sectional studies do not focus on young people but wherever available they have been reviewed. In addition, case-control studies have been reviewed where appropriate. Case-control studies are different from population studies in that they compare a group of people with a particular condition or outcome such as depression or suicide (cases) to a similar group without that condition or outcome (controls) to determine which group was exposed to the factor of interest (i.e. use of cannabis).

The evidence from these large-scale population surveys and occasional case-control studies has been reviewed below with a focus on associations between cannabis use and anxiety, depression, suicide and psychosis, as these are among the most prevalent behavioural/emotional problems experienced by adolescents and/or the most often linked to cannabis use and the most researched. Differences between the sexes are discussed where they were reported.

4.1 Cannabis and psychosis

The mental health problem most commonly linked to cannabis use in the literature is psychosis. It is important to note that the amount of research on this topic does not necessarily reflect the number of cases of psychotic disorders. The prevalence of psychotic disorders, such as schizophrenia, is much lower than other forms of mental illness such as depression and anxiety (American Psychiatric Association, 2000).

Psychotic disorders are severe mental illnesses in which hallucinations, delusions and impaired reality testing are predominant features (Hall and Pacula, 2003). Some studies have examined the association between cannabis and psychotic symptoms, which are one feature of psychotic disorders. Other studies have looked specifically at the constellation of symptoms required for a diagnosis of psychotic disorder, such as schizophrenia, a disorder characterised by distortions of reality, disturbances of thought and language and withdrawal from social contact.

This review will consider evidence for two hypotheses about the causal relationship between cannabis use and psychosis: (i) that heavy cannabis use causes a specific ‘cannabis psychosis’ which would not have occurred in the absence of cannabis use, the symptoms

of which are preceded by heavy cannabis use and remit with abstinence; and (ii) that cannabis use precipitates schizophrenia or exacerbates its symptoms (Hall and Degenhardt, 2000). In contrast to the immediate and temporary reactions of ‘cannabis psychosis’, which will be dealt with briefly, this review will focus on psychotic symptoms and the onset of schizophrenia, a far more persistent, if not chronic condition.

4.1.1 A ‘cannabis psychosis’

Large doses of THC have been reported to produce confusion, amnesia, delusions, hallucinations, anxiety and agitation (Chopra and Smith, 1974). However, evidence for a specific clinical syndrome following cannabis use that is identifiable as ‘cannabis psychosis’ is equivocal because the clinical symptoms reported by different observers have been so mixed (see Hall and Degenhardt, 2000). Such reactions are rare or rarely receive medical intervention in developed societies and remit rapidly, with full recovery, after abstinence from cannabis (Hall and Degenhardt, 2000).

4.1.2 Cannabis and psychotic symptoms

A number of general population studies, however, have found an association between regular or dependent cannabis use and psychotic symptoms. It is important to note that no information on the temporal relationship between cannabis use and the timing of the onset of psychotic symptoms is provided by these cross-sectional studies.

Using data from the US Epidemiologic Catchment Area (ECA) study, Tien and Anthony (1990) examined the relationship between drug use and a self-reported ‘psychotic experience’ (four types of hallucinations and seven types of delusional belief). They compared 477 cases who reported one or more of these symptoms in a one-year follow-up with 1,818 age-matched controls who did not. Daily cannabis doubled the relative risk (RR) of reporting psychotic symptoms, which remained after adjusting for demographic factors and baseline mental health problems (RR = 2.0; 95% CI = 1.25 to 3.12).

Thomas (1996) described the prevalence of psychotic symptoms among cannabis users in a random sample of 1,000 people drawn from the electoral role in Hastings, New Zealand. One in seven (14%) cannabis users reported “strange, unpleasant experiences such as hearing voices or becoming convinced that someone is trying to harm you or that you are being persecuted” after using cannabis (page 205). Fifty-five percent of these cannabis users (108/198) had used cannabis more than 50 times in their life.

Using data from the adult NSMHWB, a survey of a nationally representative sample of 10,641 Australian adults aged 18 years and over, Degenhardt and Hall (2001) found that cannabis dependence was associated with an increased risk of psychotic symptoms among a sub-sample of 6,722 18-49 year olds. Similar to the findings of Tien and Anthony (1990), Degenhardt and Hall (2001) found that cannabis dependence was associated with a two-fold increase in psychotic symptoms even following control for confounding factors such as age, mood and anxiety disorders, smoking status and alcohol dependence.

4.1.3 Cannabis and schizophrenia

The association between schizophrenia and cannabis use has been the subject of considerable attention in the literature (Hall, 1998). Psychotic disorders, such as schizophrenia, involve disturbances in the balance of chemicals in the brain called neurotransmitters. The neurotransmitter, dopamine, is considered to play an important

role in psychotic disorders as evidenced by the fact that drugs that increase dopamine release produce psychotic symptoms when given in large doses and antipsychotic drugs that reduce psychotic symptoms also reduce dopamine levels (Stahl, 1996).

Higher rates of substance-use disorders among persons with schizophrenia have been reported in large-scale surveys of psychiatric disorders. Using ECA data, Anthony and Helzer (1991) found that schizophrenia was 5.9 times more common among persons meeting criteria for substance abuse or dependence. Cuffel, Heithoff and Lawson (1993) subsequently reported on patterns of substance use among 231 cases of schizophrenia identified in the ECA study. The most commonly used substances were alcohol (37%) and cannabis (23%), followed by stimulants and hallucinogens (13%), narcotics (10%) and sedatives (8%). The most common combination of drugs was alcohol and cannabis (31%).

In the Australian NSMHWB, 18% of those who reported that they had been diagnosed with schizophrenia met criteria for a cannabis-use disorder (dependence/abuse) in the past 12 months and 22% met criteria for an alcohol-use disorder. After adjusting for confounding variables, those who were cannabis dependent were 2.9 times more likely to report that they had been diagnosed with schizophrenia than those without cannabis dependence (Hall and Degenhardt, 2000).

Retrospective studies involving schizophrenic patients have shown that cannabis use also worsens the symptoms of schizophrenia. Studies have found higher rates of hallucinations, delusions and other positive symptoms and more hospitalisations among current cannabis users (Negrete, Knapp, Douglas, Smith, 1986; Cleghorn, Kaplan, Szechtman, Szechtman, Brown and Franco, 1991).

4.2 Cannabis and depression

Associations between cannabis use and depression⁵ have now been reported in a number of large-scale surveys in both adolescents and adults. Chen, Wagner and Anthony (2002) analysed the United States National Comorbidity Survey data specifically to examine the co-occurrence of cannabis use and major depressive episodes. Data were from 6,792 survey participants aged 15-45 years. These authors found that a greater number of occasions of cannabis use were associated with a higher risk of having experienced a major depressive episode. Life-time cannabis dependence was associated with a 3.4 times increased risk of major depression with 9.5% of those who had experienced a major depressive episode meeting criteria for cannabis dependence compared to 4% of those who had never experienced such an episode.

In another major USA survey of mental health, the National Longitudinal Alcohol Epidemiologic Survey (NLAES), Grant (1995) found that people meeting criteria for major depression within the past year had 6.4 times the odds of meeting criteria for cannabis abuse or dependence as those without major depression in this time (6% versus 1%). Among those meeting criteria for cannabis abuse or dependence, 14% and 29% respectively met criteria for major depression in the past year (Grant and Pickering, 1998).

⁵ Depression is a state of despondency characterised by a period of abnormally depressed mood, loss of interest or pleasure in nearly all activities and decreased energy. Refer to the DSM-IV-TR (2000) or ICD-10 (1993) classification systems for a list of criteria necessary for a diagnosis of depression to be made.

Degenhardt, Hall and Lynskey (2001a) examined the relationship between different levels of cannabis use and depression (and anxiety) among adults using data from the NSMHWB. Among people who met criteria for cannabis dependence in the past year, 14% met criteria for an affective (mood) disorder compared to 6% of non-users. However, once regular tobacco use, alcohol use disorders and other drug use were taken into account in analyses, the association between cannabis use and depression was no longer significant.

In a survey of a representative sample of 1,261 young Australians aged 13-17 years, those who had used cannabis were three times more likely than those who had never used cannabis to meet criteria for depression (Rey et al, 2002). The association between depression and cannabis use remained significant after controlling for confounding factors. The authors concluded (page 220) that:

The association between cannabis use, depression, conduct problems, tobacco smoking, excessive drinking and use of illicit drugs shows a malignant pattern of comorbidity that may lead ultimately to further negative outcomes. Preventing this will require more than health education about drug issues and it will need close involvement of child and adolescent mental health services.

4.3 Cannabis and anxiety

There has been some discussion in the research literature over whether cannabis use is related to acute levels of anxiety. However, there has been little epidemiological research conducted on the association between cannabis use and more lasting anxiety levels or anxiety disorders⁶

Higher rates of drug use disorders among persons with anxiety disorders have been reported in large-scale surveys of mental health. Using ECA data, Anthony and Helzer (1991) found that anxiety disorders (panic disorder, obsessive-compulsive disorder and phobic disorders) were between 1.9 and 3.3 times more common among persons meeting criteria for drug abuse or dependence compared to those without such disorders.

Degenhardt and colleagues (2001a) are the only researchers this review is aware of to have examined the relationship between different levels of cannabis use and anxiety disorders specifically in a representative sample. Using data from the NSMHWB, these researchers found that among those with cannabis dependence in the past year, one in six (17%) met criteria for an anxiety disorder compared to 5% of non-users. Similar to their findings concerning depression, however, after taking into account regular tobacco use, alcohol use disorders and other drug use, the association between cannabis use and anxiety disorders was no longer significant. In other words, the association between cannabis use and anxiety seemed to arise because cannabis users were more likely to meet criteria for an alcohol use disorder, smoke tobacco regularly and use other drugs.

In Rey and colleagues' (2002) survey of Australian adolescents, initial analyses found that those who had used cannabis in the past month self-reported significantly more emotional (internalising) problems, including symptoms of anxiety/depression than those who did not. Scores on the anxious/depressed scales were not included in later multivariate analyses so it is not known if a relationship existed following adjustment for confounding factors.

⁶ Anxiety disorders involve the presence of anxiety that is so intense or so frequently present that it causes difficulty or distress for a person and interferes with their ability to live and work. There are a number of different types of anxiety disorders including: generalised anxiety disorder, panic disorder, phobic disorder, obsessive-compulsive disorder and post-traumatic stress disorder. Refer to DSM-IV-TR or ICD-10 for a complete listing of the criteria required for a diagnosis of each disorder.

4.4 Cannabis and suicide

A small number of studies have examined the association between cannabis use and suicide among adolescents (see Hillman, Silburn, Green and Zubrick, 2000 for a review). Beautrais, Joyce and Mulder (1999) reported a case-control comparison study of the relationship between cannabis use/dependence and serious suicide attempts that resulted in hospitalisation. These researchers compared rates of cannabis use among 302 consecutive hospital admissions making serious suicide attempts with the rates 1028 randomly selected comparison subjects in the local community. They found that among those attempting suicide, 16% met criteria for cannabis abuse or dependence, compared to 2% of the comparison subjects (Odds Ratio (OR) = 10.3; 95% CI = 5.95 to 17.8). Controlling for social disadvantage and having a diagnosis of depression or alcohol dependence substantially reduced, but did not eliminate, the association (reducing the OR to 2.0; 95% CI = 0.97 to 5.3).

Beautrais et al's (1999) study did not exclude the possibility that cannabis abuse/dependence may also make an independent contribution to the risk of suicide attempt, both directly and through its effects on the risk of other mental disorders. An analysis of cross-sectional data from the US National Comorbidity Survey by Borges, Walters and Kessler (2000) suggested that even when confounding factors are taken into account there remains a significant residual risk for suicide attempt associated with any level of regular cannabis use. They found significant associations between self-reported suicide attempts and dependence on a number of drugs, including alcohol, sedatives, stimulants, cannabis and inhalants. After adjusting for socio-demographic factors and other psychiatric disorders, such as depression and alcohol dependence, they found a two fold increased risk for first suicide attempt among the 35% of individuals surveyed who used cannabis without abuse or dependence (OR = 2.0; 95% CI = 1.5 to 2.6) which increased for the 8% who abused cannabis without dependence (OR = 2.8; 95% CI = 1.7 to 4.8) and the 8% who reported cannabis dependence (OR = 2.7; 95% CI = 1.3 to 5.5).

In Rey et al's (2002) survey of 1,261 Australian adolescents, those who had ever used cannabis were more likely to have planned suicide in the past year than those who had never used (15% versus 6%) and were more likely to have attempted suicide one or more times in the past year (10% versus 2%). In an analysis controlling for the effect of other variables significantly associated with cannabis use (e.g. age, cigarette smoking, drinking alcohol), however, these associations were no longer significant.

In summary, despite limitations in the quantity of research in this area, there is increasing evidence that regular cannabis use, typically expressed as a diagnosis of abuse or dependence and a range of mental health problems, including psychosis, depression, anxiety and suicidal thoughts/behaviours, occur together more often than might be expected by chance. While not all studies have found a significant association after taking into account confounding factors (e.g. Degenhardt et al, 2001a), the weight of evidence indicates that there is an increased chance of mental health problems among people who report problematic or dependent cannabis use. Where young people have been examined specifically, an association was found between cannabis use and depression which remained after controlling for confounding factors (Rey et al, 2002). Differences in results do not necessarily mean inconsistent findings but may reflect differences in the strength of association in adult versus adolescent samples. The next section will discuss some of the possible explanations for this apparent association between cannabis use and mental health problems.

5 Explaining the relationship between cannabis use and mental health problems

Although associations between regular cannabis use and mental health problems have been reported by a number of studies the explanation for these associations remains contentious. Three broad types of explanation need to be considered: that cannabis use is one of the causes of mental health problems; that mental health problems are one of the causes of cannabis use; and that cannabis use and poor mental health are not directly related but share common causes (e.g. social and environmental factors).

5.1 Cannabis use causes mental health problems

The first explanation of the observed association is that cannabis use is one of the causes of poor mental health outcomes, either through related effects on interpersonal and role functioning or direct effects on physiological functioning. Kandel and her associates have argued that the early use of an illicit drug has three general consequences for later development. First, early usage encourages later usage of the drug. Secondly, illicit drug use has an impact on anti-conventional behaviours and is associated with increased risks of delinquency, employment problems and difficulties in interpersonal relationships. Thirdly, these consequences vary with the individual's cumulative use of the drug. These authors propose a general model in which illicit drug use sets in train a cascade of events that leads to further drug use and an increased risk of problems of adjustment (Kandel, Davies, Karus and Yamaguchi, 1986; Kandel, Yamaguchi and Chen, 1992).

With respect to psychotic disorders, a number of researchers have suggested that cannabis may play a causal role in precipitating schizophrenia due to its biological effects (van Os, Bak, Hanssen, Bijl, Graaf and Verdoux, 2002; Hall and Degenhardt, 2000; Degenhardt and Hall, 2002). There are a number of reasons why it is a plausible hypothesis: THC acts on similar neurotransmitter systems to those implicated in psychotic disorders; THC produces some symptoms found in psychotic disorders such as euphoria, distorted time perception and memory impairment; high doses of THC have produced psychotic symptoms in normal volunteers; and clinical observations have described 'cannabis psychoses' (see Section 4.1.1) (Hall and Pacula, 2003). It has also been suggested that cannabis use may cause changes in neurotransmitter systems that make depressed mood (Degenhardt, Hall and Lynskey, 2003) and suicide (Holden and Pakula, 1998) more likely, although as yet there is no research evidence to support these proposals.

5.2 Cannabis use is a consequence of mental health problems

An alternative hypothesis to explain the association between mental health problems and cannabis use is the 'self-medication' hypothesis, that is, that people develop substance use problems as a result of their attempts to self-medicate symptoms of an existing mental health problem. For example, people with depression may use cannabis to improve their mood or persons with schizophrenia may use cannabis to alleviate unpleasant psychotic symptoms or the effects of their medication. Research on self-reported reasons for substance use among people with severe mental illnesses, such as schizophrenia, provides some support for this idea (e.g. Mueser, Drake and Wallach, 1998), however, the reasons

are also similar to those given by people who do not have mental health problems, such as to relieve boredom, to relax, to provide stimulation, to feel good and to provide social interaction (Mueser, Bellack and Blanchard, 1992; Warner, Taylor, Wright, Sloat, Springett, Arnold and Weinberg, 1994).

Some researchers have argued that the primary direction of risk among young people lies from mental disorder to cannabis use rather than the reverse (McGee, Williams, Poulton and Moffitt, 2000). However, rather than reflecting the use of cannabis for self-medication they argue a more differential drift towards substance use among adolescents who show acting-out behaviours which are non-conventional in the first place.

5.3 Common causes

The final explanation is that the observed associations between cannabis use and mental health problems are not causal but are instead the result of common factors that increase the likelihood of both cannabis use and mental health problems. It is well documented that the use of cannabis is more frequent among young people from disadvantaged backgrounds, with early adjustment problems, who have early depression, are exposed to unemployment, experience poor academic achievement, and those with difficult or dysfunctional childhood circumstances (McGee et al, 2000; Jessor, Chase and Donovan, 1980; Alpert, Maddocks, Rosenbaum and Fava, 1994; Fergusson and Horwood, 1997; Hartnagel, 1997; Fergusson, Horwood and Beautrais, 2003; Velez, Johnson and Cohen, 1989). Given these linkages between the use of cannabis and early psychosocial adversity it has been argued that the higher rate of problems found among cannabis users arises because cannabis use is more common among young people from at-risk backgrounds rather than because of any cause and effect association between the use of cannabis and mental health problems. There is considerable indirect evidence to support this hypothesis because there is a high degree of similarity between the factors associated with cannabis use, other drug use and mental health problems. These include factors such as social disadvantage, parental psychiatric illness, family dysfunction and history of behaviour problems in childhood (Rutter, 1987; Velez et al, 1989; McGee et al, 2000).

6 Longitudinal studies of cannabis use and mental health outcomes

6.1 The logic of longitudinal studies

The cross-sectional surveys cited so far show that people who use cannabis are at increased risk of poor mental health outcomes. As outlined by Lynskey and Hall (2000), however, cross-sectional surveys do not enable researchers to determine which is cause and which is effect. It is not possible to conclude from these studies whether the associations between cannabis use and mental health problems arise because: cannabis use causes mental health problems such as psychosis, depression and anxiety; mental health problems cause cannabis use; or both reflect the common influence of social, genetic and individual factors which increase the risks of each outcome.

To be able to distinguish between these explanations, it is necessary to have data from prospective longitudinal studies (Lynskey and Hall, 2000). Longitudinal studies are studies in which a large representative group of individuals are assessed over time on cannabis use and mental health, plus other factors that may affect the relationship, that is, differences between cannabis users and non users (e.g. personal characteristics and life experiences before using cannabis). These longitudinal studies have a number of major advantages over cross-sectional studies (Rutter, 1988). Firstly, with longitudinal studies researchers are able to specify which came first, cannabis use or the mental health problem. Secondly, the problems associated with recalling cannabis use and behaviour retrospectively are reduced. Thirdly, researchers can begin to examine the causal pathways between cannabis use and mental health outcomes by statistically adjusting for the effect of confounding factors. That is, researchers can begin to answer the question: do young people who use cannabis have poorer mental health than those who do not, when adjustment is made for the fact that those who use cannabis regularly at a young age are more likely to experience life circumstances which increase their risk of poorer mental health before they used cannabis?

A number of recent prospective longitudinal studies have examined the associations between cannabis use and mental health outcomes. A key aim of many of these studies has been to determine the extent to which cannabis use is a risk factor for later mental health problems and other adverse outcomes. These studies have assessed cannabis use and mental health status on a number of occasions over time. They have also assessed factors on which cannabis users and non-users may differ, such as demographic and family factors, in order to take these differences into account. These studies have used statistical methods to determine the extent to which prior cannabis use is associated with later mental health problems after the effects of confounding factors have been taken into account.

6.2 Major longitudinal studies of cannabis and mental health

6.2.1 Cannabis and psychotic symptoms/schizophrenia

It is worth noting that the literature reviewed in this section refers to a range of psychotic conditions. At one extreme it refers to the self-reported presence of psychotic symptoms (e.g. Fergusson, Horwood and Swain-Campbell, 2003). At the other extreme, it means

hospitalisation with a confirmed diagnosis of schizophrenia (e.g. Zammit et al, 2002). Between these extremes are studies that have as outcomes the diagnosis of psychotic and schizophreniform disorder (e.g. van Os et al, 2002 and Arseneault et al, 2002). It is common in the literature to use the term 'schizophrenia' as a catchword to describe a continuum of psychotic symptoms and full-blown disorders in the schizophrenia spectrum (Smit, Bolier and Cuijpers, 2004). In reviewing the individual studies below, however, precise descriptions of the outcomes examined have been used.

The strongest evidence that cannabis use may be a risk factor for later schizophrenia comes from a 15-year cohort study of cannabis use among 50,465 Swedish conscripts (Andreasson, Engstrom, Allebeck and Rydberg, 1987). This study investigated the relationship between self-reported cannabis use at age 18 and the risk of receiving a diagnosis of schizophrenia in the next 15 years. Andreasson et al (1987) found that the relative risk of receiving a diagnosis of schizophrenia was 2.4 times higher among those who had tried cannabis by age 18 compared to those who had not. There was a dose-response relationship⁷ between cannabis and diagnosis of schizophrenia with the risk of developing schizophrenia 1.3 times higher for those who had used cannabis on 1-10 occasions, 3 times higher for those who had used cannabis between one and 50 occasions and 6 times higher for those who had used cannabis more than 50 times. These risks were substantially reduced after statistical adjustment for variables that were related to the risk of developing schizophrenia, such as having a psychiatric diagnosis at conscription and having parents who had divorced (used as a proxy for parental psychiatric disorder). Nevertheless, the relationship remained statistically significant.

A longer follow-up (27 years) and reanalysis of the Swedish conscript cohort by Zammit, Allebeck, Andreasson, Lundberg and Lewis (2002) confirmed the results of this study, finding that cannabis was associated with a dose-dependent, increased risk of schizophrenia. The association was not explained by personality traits or use of other psychoactive drugs. After adjusting for a variety of factors, including diagnosis of psychiatric illness on conscription, poor social integration, place of upbringing and cigarette smoking, it was found that those who had used cannabis on more than 50 occasions were 3 times more likely to develop schizophrenia after conscription than those who had never used the drug (95% CI = 1.7 to 5.5). The authors stated that self-medication with cannabis was an unlikely explanation for the association observed and that the results indicated a risk to the mental health of people who use cannabis, particularly in the presence of other risk factors for schizophrenia.

A Dutch three-year follow-up study of a general population of 4,045 people free of psychosis and 59 with a baseline diagnosis of psychotic disorder also showed a dose-response association between use of cannabis and psychotic symptoms in both groups. Analyses revealed that the effect of cannabis use was much stronger in those with a baseline diagnosis of psychotic disorder than in those without. Cannabis use was also associated with a poorer prognosis for those with an existing psychosis (van Os et al, 2002). The authors concluded (page 326) that the study confirms previous suggestions that:

...cannabis use is an independent risk factor for the emergence of psychosis in psychosis-free persons and that those with an established vulnerability to psychotic disorder are particularly sensitive to its effects, resulting in a poor outcome.

⁷ A dose-response relationship refers to the relationship between the dose of some agent (in this case cannabis) or the extent of exposure (to cannabis) and a response (in this case a diagnosis of schizophrenia). A dose-response effect means that as the dose increases so does the effect.

There are two important longitudinal studies examining cannabis use in adolescence and early adulthood that have been able to account for psychotic symptoms predating cannabis use and therefore examine whether cannabis use is secondary to pre-existing psychosis. Arseneault, Cannon, Poulton, Murray, Caspi and Moffit (2002) examined adolescent cannabis use as a risk factor for adult schizophreniform disorder⁸ in the large-scale Dunedin multidisciplinary health and development study. Information on psychotic symptoms from a sample of 759 individuals born in 1972-73 was collected at age 11. Drug use information was collected at ages 15 and 18 years from self-reports and psychiatric symptoms assessed at age 26 years. Their analyses indicated that, after controlling for psychotic symptoms preceding the onset of cannabis use, individuals who had used cannabis three times or more by age 15 or 18 years showed more 'schizophrenia symptoms' (but not schizophrenia) than controls, indicating that cannabis use is not secondary to a pre-existing psychosis. There was also an interaction between psychosis risk and age of onset of cannabis use, with early cannabis use (by age 15) being more strongly related to psychosis than later cannabis use (by age 18). There was also the suggestion of an interaction between cannabis use and vulnerability, with a higher risk of psychosis among cannabis users who reported psychotic symptoms at age 11. They also found that risk was specific to cannabis use and not use of other drugs. The authors stated about their findings (page 1213):

Although most young people use cannabis in adolescence without harm, a vulnerable minority experience harmful outcomes. A tenth of the cannabis users by age 15 in our sample (3/29) developed schizophreniform disorder by age 26 compared with 3% of the remaining cohort (22/730). Our findings suggest that cannabis use among psychologically vulnerable adolescents should be strongly discouraged by parent, teachers and health practitioners. Policy makers and law makers should concentrate on delaying onset of cannabis use.

Fergusson, Horwood and Swain-Campbell (2003) were able to adjust for a very wide range of demographic, individual and social variables due to the extensive dataset established on their birth cohort of 1265 New Zealand children in the Christchurch Health and Development Study (CHDS). The availability of longitudinal data collected in this study made it possible to statistically adjust the associations between cannabis use and psychotic symptoms for pre-existing symptom levels, plus a wide range of other potentially confounding factors. Their analysis showed that following such adjustments, young people meeting criteria for cannabis dependence at age 18 years had rates of psychotic symptoms at age 21 years that were 1.8 times those of young people not meeting criteria for cannabis dependence (95% CI = 1.2 to 2.6). The authors concluded (page 20) that their findings were consistent with the view that:

...heavy cannabis use may make a causal contribution to the development of psychotic symptoms since they show that independently of pre-existing psychotic symptoms and a wide range of social and contextual factors, young people who develop cannabis dependence show elevated rates of psychotic symptoms.

⁸Schizophreniform disorder is identical to schizophrenia except for its duration (i.e. the disturbance lasts from 1 to 6 months compared to at least 6 months for schizophrenia) and the absence of a requirement that there be impaired social or occupation functioning during the illness (American Psychiatric Association, 2000).

The longitudinal studies find consistent associations between cannabis use in adolescence and the occurrence of psychotic symptoms in early adult life. However, in the studies so far reviewed, subjects have usually been assessed once a year or less often and asked to report retrospectively on cannabis use and psychotic symptoms during the preceding number of years. There is uncertainty, therefore, about the temporal relationship between cannabis use and the timing of the onset of psychotic symptoms. A recent study by Verdoux, Sorbara, Tournier and Swendsen (2003) provides a unique piece of evidence in that the time periods measured were several hours and the association between cannabis use and psychotic symptoms could be assessed in a relatively exact manner. These researchers asked 79 college students to report on their drug use and experience of psychotic symptoms at randomly selected time points, several times each day over 7 consecutive days. High (use at least 2-3 times a week) cannabis users and students identified as vulnerable to psychosis were over-represented in this sample. These researchers also found that cannabis use and psychotic symptoms were associated; that this association remained after adjusting for other drug use, age and gender; and that the relationship depended upon the individual's level of vulnerability for psychosis, with a higher risk of psychosis among those who were vulnerable. There was no evidence that use of cannabis increased following occurrence of psychotic experiences as would be expected by the self-medication hypothesis.

In summary, evidence is increasingly suggesting that cannabis use may place persons who are vulnerable to developing psychotic symptoms at particular risk of developing such symptoms and perhaps of developing lasting psychotic disorders such as schizophrenia. The research has indicated that: cannabis use precedes psychosis; and that the risk of psychosis is higher for those who begin use at an earlier age, are regular cannabis users and have a history of psychotic symptoms. These relationships and the fact that they persist after controlling for confounding factors, make it more likely than not that cannabis use has a causal role in the onset of psychotic symptoms and disorders. As summarised by Smit, Bolier and Cuijpers (2004) in a recent review examining many of the longitudinal studies outlined above (page 429):

Five recent, longitudinal and carefully executed studies offer converging evidence that cannabis use does indeed increase the risk of schizophrenia and other psychotic disorders. This conclusion applies throughout the range of symptoms and full-blown disorders in the schizophrenia spectrum.

It is uncertain, however, whether cannabis use primarily precipitates psychosis in those who are at increased risk for a variety of other reasons or whether cannabis use causes psychotic disorders in people who otherwise would not have developed the disorder. The former hypothesis is more plausible than the latter as there has been a declining incidence of treated cases of schizophrenia (Der, Gupta and Murray, 1990) over the period when cannabis use among young adults in Australia and North America has increased substantially (Donnelly and Hall, 1994). A paper modelling the situation in Australia indicated that it is not easy to choose between these hypotheses, but concluded that cannabis use may precipitate psychotic disorders in persons who are vulnerable to developing psychosis and worsen the course of the disorder among those who have already developed it (Degenhardt, Hall and Lynskey, 2003b). In their review, Smit et al (2004) go further and state (page 425):

...antecedent cannabis use appears to act as a risk factor in the onset of schizophrenia, especially in vulnerable people, but also in people without prior history.

6.2.2 Cannabis and depression and anxiety

A study involving the Dunedin, New Zealand cohort found that rates of cannabis use were higher among young people with mental disorders (including anxiety and depressive disorders) at 15, 18 and 21 years of age (McGee et al, 2000). Cannabis use at age 15 years did not predict mental health problems at age 18 years but having mental health problems at age 15 years (conduct, oppositional and attention deficit hyperactivity disorders) predicted cannabis use at age 18 years. Cannabis use at age 18 years also predicted alcohol dependence and conduct disorders at age 21 years. McGee et al argued that the lack of a relationship between cannabis use and anxiety and depressive disorders suggests that cannabis use was not a form of self-medication in anxious and depressed individuals. They do, however, argue that among young people the primary direction of risk lies from mental disorder to cannabis use rather than the reverse and that adolescents who exhibit acting-out, non-conventional behaviours are more susceptible to substance use.

In a later study of the same cohort, Arseneault et al (2002) did not find an association between the use of cannabis three times or more by age 15 years and depressive disorder at age 26 years. However, people who had used cannabis three times or more by age 18 years were more likely to have a depressive disorder at age 26, even after controlling for covariates such as use of other drugs, socioeconomic status and gender.

Fergusson and Horwood (2001) have reported the most comprehensive examination of the 'common cause' hypothesis using data on an extensive range of potential confounding factors gathered in the Christchurch study. In an early report, adolescents who had used cannabis 10 or more times by the age of 15-16 years were more likely to also meet criteria for a mood and anxiety disorder at 14-16 years (Fergusson and Horwood, 1997). Specifically, 36% of those who had used cannabis 10 or more times met criteria for a mood disorder, compared to 18% of those who had used cannabis one to nine times and 11% of those who had never used cannabis; 44% met criteria for an anxiety disorder, compared to 32% of those who had used cannabis one to nine times and 29% of those who had never used cannabis. However, after controlling for the effects of confounding individual, familial, peer and socio-demographic variables, cannabis use at age 15-16 years was not associated with depression or anxiety disorder at age 16-18 years (Fergusson and Horwood, 1997).

Using data from the same cohort and with a longer follow-up period, Fergusson, Horwood and Swain-Campbell (2002) examined linkages between the extent of cannabis use and measures of psychosocial adjustment including: property crime; depression; suicidal behaviours and other illicit drug use. In this analysis, they examined heavier patterns of cannabis use than in their earlier study, which used the low cut-off of 10 or more uses of cannabis in a life-time to define heavy use. They found that by age 20-21 years, 30% of those using cannabis at least weekly met criteria for depression, compared to 15% of those who did not use cannabis at that age. Analyses adjusting for socio-demographic and individual factors, adverse life events, peer affiliations, school and home leaving age and alcohol dependence reduced the association substantially, but a significant association remained between cannabis use during adolescence and depression, juvenile crime, suicidal ideation and suicide attempts in the same year. After adjustment, use of cannabis weekly or more in a given year was associated with a 1.7 times greater risk of reporting depression in the same year. The authors concluded (page 1133) that:

Cannabis use, and particularly regular cannabis use, is associated with (smaller but) detectable increases in crime, depression and suicidal behaviours even when confounders are taken into account. The adverse effects of cannabis on adjustment seem to be most pronounced for younger users and decline with increasing age.

Recently, Goodwin, Fergusson and Horwood (2004) examined linkages between anxiety disorders and substance dependence also using data from the Christchurch cohort. Although cannabis dependence was subsumed under illicit drug dependence in this study, the results are noteworthy as the researchers adjusted for such an extensive range of potential confounding factors including fixed factors, such as childhood, social and family risk factors and time-dynamic factors, such as prior history of substance dependence, major depression and affiliations with deviant peers. Analyses showed that young people aged 16-18 years and 18-21 years with anxiety disorders had odds of illicit drug dependence (which includes cannabis dependence) that were 3.9 and 1.3 times higher than young people without anxiety disorders, respectively. However, these associations with both illicit drug dependence and any drug dependency examined (e.g. alcohol, nicotine) were largely explained by factors relating to: childhood and family factors such as exposure to family adversity and parental psychopathology; prior substance dependence; concurrent major depression; and concurrent affiliations with deviant peers. After adjustment for these factors, anxiety disorder was unrelated to all measures of substance use. The authors concluded (page 303) that:

...the weight of the evidence from this study suggests that the linkages between anxiety disorders and substance dependence are largely or wholly non causal and reflect the net effects of a series of fixed and time dynamic factors that are correlated with the development of both anxiety disorders and substance dependence disorders.

An Australian study of 1,601 students followed from age 14-15 years for seven years examined the link between early-onset regular cannabis use and depression and anxiety in young adulthood (Patton, Coffey, Carlin, Degenhardt, Lynskey and Hall, 2002). This study found a dose-effect relation between the use of cannabis and anxiety and depression with higher rates according to the frequency with which cannabis was used. This link was stronger for young women than young men although sex differences have not been found in other studies (e.g. Rey et al, 2002; Bovasso, 2001). Among females only, daily cannabis use in adolescence predicted a fourfold increase in rates of depression and anxiety at 20-21 years (OR = 4.2; 95% CI = 1.6 to 11); weekly cannabis use predicted a twofold increase in risk (OR = 2.3; 95% CI = 1.3 to 4.2). These relationships were adjusted for confounding factors including socio-demographic variables, alcohol use and antisocial behaviour. In contrast, depression and anxiety in teenagers did not predict later weekly or daily cannabis use and therefore the results did not support the self-medication hypothesis. The authors concluded (page 1198) that:

These findings contribute to evidence that frequent cannabis use may have a deleterious effect on mental health beyond a risk for psychotic symptoms. Strategies to reduce frequent use of cannabis might reduce the level of mental disorders in young people.

In the only longitudinal study to examine the relationship between cannabis use and depression in adulthood, Bovasso (2001) used 14-16 year follow-up data from the participants in the ECA study. Participants who reported cannabis use and at least one symptom of cannabis abuse/dependence at baseline were 4.5 times more likely to report depressive symptoms in the follow-up period than those who reported they were non-abusers. After adjusting for baseline depressive symptoms and demographic variables, the relationship had changed little (OR = 4.0; 95% CI = 1.23 to 12.97). Among those who did not meet criteria for cannabis abuse at baseline, depressive symptoms at baseline failed to significantly predict an increase risk of cannabis abuse at the follow-up assessment, a finding that also goes against a self-medication hypothesis.

In summary, longitudinal studies have provided mixed evidence on the nature of the association between cannabis use and depression and anxiety. The dose-response relation for depression and anxiety found in a number of these studies suggests that heavy cannabis use may increase depressive and anxiety symptoms among some users. After controlling for potential confounding variables in the association between regular or problematic cannabis use and depression and anxiety the risk is much reduced but generally a modest relationship remains. It is still too early, however, to rule out the association being due to other common factors that increase the risk of both heavy cannabis use and depression and anxiety (e.g. Goodwin, Fergusson and Horwood, 2004). There is little evidence of an increased risk of later cannabis use among people with depression or anxiety and hence little support for the self-medication hypothesis.

6.2.3 Cannabis and suicide

Using data gathered from the birth cohort of 1,265 children born in Christchurch, Fergusson and Horwood (1997) found a dose-response relationship between frequency of cannabis use by age 16 years and the likelihood of reporting a suicide attempt, but the association did not remain after controlling for confounding factors. In a later analysis, looking at heavier patterns of cannabis use, Fergusson, Horwood and Swain-Campbell (2002) found a dose-response relationship between frequency of cannabis use at ages 14-15 years and 17-18 years and reporting suicidal ideation and a suicide attempt. After control for confounding factors in this analysis, weekly cannabis users remained at significantly increased risk of suicidal ideation and suicide attempts. The effects of cannabis use on suicidal behaviours varied with age, with younger (14-15 year old) users being more affected by regular cannabis use than older (20-21 year old) regular users. After adjustment, use of cannabis weekly or more often among 14-15 year olds was associated with a 13 times greater risk of reporting a suicide attempt in the same year compared to non-users. The association declined with age so that by the time the cohort was aged 20-21 years there was no significant association with weekly cannabis use and suicide attempt.

Patton, Harris, Carlin, Hibber, Coffey, Schwartz and Bowes (1997) reported a longitudinal study on suicide attempts and self-harm in a cohort of 2,066 Victorian secondary school students followed from age 15-16 years to age 21 years. Using regression models in which potential demographic confounders (age, gender and parental marital status) were taken into account, high levels of depression and anxiety symptoms were shown to have the strongest association with self-harm for both males and females. Weekly cannabis use was also found to be independently associated with a five-fold increase in self-harm among females, but no such association with cannabis use was found among males.

In their follow-up of 50,465 Swedish conscripts, Andreasson and Allebeck (1990) found the risk for suicide by heavy cannabis users was four times that of non-users, while lesser/casual use was not associated with an increased risk. A more detailed analysis of predictors of suicide in this cohort reported by Allebeck and Allgulander (1990) found that inpatient psychiatric hospitalisation by age 18 was the strongest predictor of suicide risk (OR = 11.3). Use of 'narcotics' (which includes cannabis in this study) did not predict suicide independently of a psychiatric diagnosis (OR = 1.3) but a diagnosis of alcohol dependence (OR = 4.3) and drug dependence (OR = 3.6), which includes cannabis dependence, did.

In summary, the evidence from the small number of longitudinal studies concerning the relationship between cannabis use and suicide among adolescents is mixed. It is certainly the case that when factors such as the use of alcohol and other drugs, depression and

having a history of psychiatric treatment are taken into account the association is substantially reduced. Whether cannabis use makes an independent contribution to the risk of suicide, either directly or through its effects on the risk of other mental disorders, remains to be clarified by further research. The study by Fergusson et al (2002) which controlled for an extensive range of potential confounding factors does suggest, however, that there may be increased risk of suicide among younger, regular users of cannabis.

7 Summary

Cross-sectional and longitudinal research indicates that young people who use cannabis are at increased risk of poor mental health outcomes and other adverse outcomes including suicide, other substance use and abuse, criminal behaviour, impaired educational achievement and reduced life opportunities. The longitudinal studies suggest that these associations are partly explained by the fact that the factors that predispose young people to use cannabis overlap with the same factors that predict higher risk of these adverse outcomes (e.g. social and environmental factors such as adverse life events, family dysfunction, behavioural and emotional problems in childhood). Overall, it appears that young people who use cannabis in early adolescence are those who were at greatest risk of experiencing mental health problems, using other drugs, doing poorly at school, attempting suicide, having deviant peer affiliations and displaying antisocial behaviour before they began to use cannabis.

However, a 'common causes' model does not completely explain all the relationships between cannabis use and these poorer social outcomes. The evidence increasingly suggests that regular cannabis use, particularly among those who begin using at an early age, adds to the risk of mental health problems in adolescents who are at risk for other reasons.

A plausible mechanism that may explain these associations has been suggested by Patton et al (2002), namely that the effects of regular or problematic cannabis use are socially mediated. These researchers suggest that the social consequences of regular use, including educational failure, school dropout, unemployment and crime, are all factors that may lead to higher rates of mental disorders. Similarly, Fergusson and Horwood (1997) have suggested that early cannabis use appears to encourage a series of behaviours including affiliation with delinquent and substance-using peers, early school leaving and moving from home that in turn increases risks of substance abuse, antisocial behaviours and unemployment. These explanations are generally consistent with the conclusions of Kandel and associates who have argued that cannabis use may set in train a cascade of consequences that increase later psychosocial risk (Kandel et al, 1986).

The question of direct pharmacological effect also remains, particularly as some studies have found that risks seem confined largely to daily users (Patton et al, 2002). There is also evidence that a genetic vulnerability to psychosis increases the risk that cannabis users will develop psychosis (e.g. Arseneault et al, 2002; McGuire, Jones, Harvey, Williams, McGuffin and Murray, 1995). A plausible biological mechanism underlying a causal association of cannabis use and psychosis has been suggested. THC modifies dopamine transmission, the neurotransmitter considered to play an important role in psychotic disorders and may therefore interact with a pre-existing genetically or environmentally determined vulnerability for dopaminergic system dysregulation (Verdoux et al, 2003). Abnormalities of cannabinoid receptors or endogenous cannabinoid compounds (substances that occur naturally in the brain) may also be involved in psychosis and exposure to exogenous cannabinoids like cannabis may reveal or exacerbate pre-existing dysfunctions. Cannabinoid receptors are found widely in the central nervous system, with a distribution that is consistent with effects on a wide range of brain functions including memory, emotion, cognition and movement (Ameri, 1999).

8.1 Interventions to reduce the effects of early cannabis use on mental health

The studies reviewed have a number of implications for the identification and treatment of mental health problems related to cannabis use. Firstly, children who have mental health problems are among those at greatest risk of early cannabis use. In addition, regular cannabis users are likely to be over-represented among adolescents who have poor mental health outcomes. Additional support for those children identified as at higher risk than average for mental health problems and drug use may be an effective way of reducing early and heavy cannabis use in adolescence.

As has been outlined in this and previous reviews (Lynskey and Hall, 2000), early cannabis use shares a set of risk factors, such as social disadvantage, family problems, familial conflict and parental drug and alcohol problems, with a range of other adverse social outcomes, such as mental health problems, delinquency, poor school performance and attempted suicide (Fergusson and Horwood, 1997). In terms of the implications this has for prevention of cannabis use among school students it suggests that efforts should be part of broadly targeted intervention strategies in early childhood rather than the focus of interventions directed only at cannabis (and other drug) use.

Broad-based intervention programs can also be implemented in adolescence. A realistic goal of these programs may be to reduce the contribution that cannabis use makes to the poor mental health outcomes of high risk and disadvantaged adolescents whose life circumstances puts them at increased risk of early initiation into cannabis use. *MindMatters* is a Commonwealth funded health and wellbeing resource for all secondary schools. *MindMatters* suggests that health and wellbeing can be addressed through curriculum, the way that teachers teach and relate to students, the ethos of the school, school-community partnerships and working with parents. Another broad-based mental health promotion intervention is the Gatehouse Project (Patton, Bond, Butler and Glover, 2003; Patton, Glover, Bond, Butler, Godfrey, Di Pietro and Bowes, 2000). In designing the intervention, existing research was reviewed and evidence drawn from public health, education, psychology and psychiatry which suggested that a focus on promoting emotional wellbeing would have a positive effect on many outcomes, including substance use, self-harming behaviours, academic performance and school engagement.

Health messages regarding the association between regular cannabis use and increased risk for mental health problems need to be made available to young people, their parents and the community. As argued by Hall (2004), it is not necessary to be certain that there is a causal relationship before advising young people about how to reduce their risk. The challenge will be to communicate the risk while honestly acknowledging the uncertainties that remain. For instance, quite a lot is now known about the relationship between cannabis use and psychosis. It is clearest that young people with psychosis or a first-degree relative with psychosis are at highest risk of experiencing psychotic symptoms after using cannabis. Hall (2004) argues these people should be advised to avoid using cannabis as well as other psychosis-inducing drugs, including alcohol and stimulants (e.g. amphetamines). Young people who have experienced symptoms of anxiety and depression

should also be included as among the 'at risk', given the non-specific nature of the early symptoms of psychosis. For young people who do not belong to an identifiable 'high risk' group, those who report unpleasant, psychotic-like symptoms after using cannabis are probably at greatest risk of developing a psychosis and should be encouraged to cease use. Young people who do not experience such effects need to be made aware that some of their peers may, as peer influence can be an important factor in young people's drug use (Hall, 2004). Persuading young people that regular, especially daily, cannabis use is not a 'safe' pattern of use may also reduce any role it plays in precipitating psychosis and other mental health problems.

An important consideration is the timing and content of education about cannabis and mental health. As the age of initiation to cannabis use is decreasing, it would seem sensible to begin efforts in early adolescence. A study of young people's attitudes and beliefs about cannabis use and drug education conducted for the NSW Department of Education and Training (Copeland et al, 2001) found that on the whole, students reported that their experiences of school drug education were positive and credible. Most participants believed cannabis education should commence at the beginning of secondary school. Adolescence is a period of profound change and developmental variations occur in younger versus older adolescents in peer influence, maturation and cognitive, affective and social development. Therefore, education and interventions directed toward adolescents need to address contextual factors that are different from those of adults. These factors include the influence of perceived peer group norms on behaviour; shorter histories of cannabis use (with fewer apparent negative health effects); and developmentally different affective, cognitive, decision-making and planning processes. For example, a recent study of illicit drug use among 11 to 12 year olds (McIntosh, MacDonald and McKeganey, 2003) found that many children's views, particularly about the dangers of drugs, were uninformed, incorrect and inconsistent. Given the developmental level of this age group, it was not surprising that most of the young people interviewed had vague, limited and often incorrect knowledge about illicit drugs, which is a poor basis on which to make informed decisions. Understanding these developmental and contextual factors will facilitate designing strategies that are flexible in their delivery and allow for variations in developmental stage and the salient issues influencing cannabis use and mental health for adolescents.

Young people should also be informed about the association between regular cannabis use, the risk for later dependence and the variety of other adverse outcomes (e.g. poor school performance, early school leaving and the use of other illicit drugs). A number of studies have found the risk of psychosis and other adverse mental health outcomes is most marked for those who begin using cannabis at an early age. Delaying the average age of onset of cannabis use should be a focus of any prevention and health promotion program.

For adolescents who are already involved in regular cannabis use, specific interventions may be required. The dose-response relationship found between cannabis and mental health problems in many of the studies reviewed highlights the importance of reducing the frequency of cannabis use among adolescents. Adolescents should be encouraged to remain at school as early school leaving is more likely to entrench these young people in a non-conforming, deviant lifestyle (Lynskey and Hall, 2000). The development, trial and evaluation of treatment programs for this group of adolescents is a priority.

Marijuana matters: a cannabis intervention program, developed by the NSW Department of Education and Training, is the first school based intervention program in Australia developed specifically to meet the needs of school aged students experiencing problems as

a consequence of cannabis use. It is a six week small group program conducted by the school counsellor and a worker from the Local Area Health (Alcohol and Other Drugs) Service. It provides young people with an opportunity to discuss their problems and receive help in a secure, supportive environment.

The Cannabis Check-up approach (Bergius, Swift, Copeland, Roffman and Stephens, in press) is a promising way of assisting adolescent cannabis smokers. Based on the Drinker's Check-up (Miller and Sovereign, 1989), it is one of a range of brief interventions that use motivational enhancement techniques to increase motivation to change; these have been shown to be useful in addressing alcohol and other substance use problems in adults and adolescents (Burke, Arkowitz and Menchola, 2003; Dunn, Deroo and Rivara, 2001; Monti, Colby and O'Leary, 2001). The Check-up can be tailored for young people who may not have thought much about their cannabis use. Young people are recruited from schools and the community at large, as well as those actively seeking treatment. It is brief (2-3 sessions) and easy to access, offering an opportunity for a confidential and in-depth discussion of cannabis use rather than a more formal treatment intervention that may include expectations for change. This is important because the Check-up seeks to attract people who may not be committed to making changes in their use. In other words, the level of motivation for change is not presumed, but explored as part of the intervention. The approach views ambivalence about cannabis use as normal, does not label young people as having a problem with cannabis and treats them as the experts and decision-makers regarding their cannabis use. This approach increases the likelihood the young person will feel engaged and empowered and therefore more likely to consider changes to their use.

While not targeting heavy users, a recent feasibility study of the Check-up among young cannabis users in Sydney found that the young people recruited into the program had very high rates of cannabis use and dependence. Despite this, it produced encouraging results, attracting and retaining young cannabis users and resulting in decreases in use and related problems (Martin, Swift and Copeland, 2004). Similarly promising results have come from a British randomised controlled trial, in which young college students who received a single session of motivational interviewing showed reductions in cannabis and other drug use compared to those receiving their normal college education but no intervention specifically targeting drug use (McCambridge and Strang, 2004). An advantage of brief motivational approaches such as these are that they can be taught to and implemented by, a variety of personnel, such as general practitioners, alcohol and other drug workers and school counsellors.

Clearly, those involved in the treatment of problematic or dependent cannabis use need to screen for other mental health problems. It is crucial that clinicians working with young people with psychosis and other mental health problems ask about cannabis and other drug use (see Hinton, Elkins, Edwards and Donovan, 2002 for a treatment manual for early psychosis and cannabis use). Comorbid anxiety and affective disorders will be common among persons seeking treatment for cannabis dependence and these disorders, if untreated, could affect the outcome of treatment.

8.2 Some research priorities

The review by Lynskey and Hall (2000) suggested a number of research priorities and these remain relevant. The evaluation of early intervention programs for children at risk of cannabis use and other adverse social outcomes is an obvious social and research priority. If interventions actually delay onset of cannabis use, or prevent use altogether, subsequent

follow-up through young adulthood may help clarify whether experimentally induced reductions in cannabis use are followed by a reduced risk of mental health problems.

Another research priority would be to obtain data from longitudinal studies of Australian adolescents to discover to what extent the findings of longitudinal studies in New Zealand and the USA are applicable to Australia. These studies would also help to better understand adolescent health and development more generally. Any such studies that are undertaken should collect data on cannabis and other drug use. In the meantime, advantage could be taken of the Australian longitudinal studies that have been initiated and have collected information on alcohol, tobacco and cannabis use and mental health outcomes. In other studies already collecting mental health data, questions on cannabis use could be included in subsequent data collections.

There is also a need to examine to what extent genetic factors explain the association between cannabis use and mental health problems; behavioural genetic research could examine this possibility. Further research examining the possible biological mechanisms underlying the association is also warranted.

This report demonstrates that there have been substantial advances in recent years in terms of our understanding of the relationship between cannabis use and mental health, particularly through large-scale longitudinal research. Further research, examining in particular the possible pathways by which regular cannabis use may lead to mental health problems, will guide more effective prevention and intervention strategies.

- Achenbach, T. M. and Edelbrock, C. S. (1978). The classification of child psychopathology: A review and analysis of empirical efforts. *Psychological Bulletin*, 85(6), 1275-1301.
- Allebeck, P. and Allgulander, C. (1990). Psychiatric diagnoses as predictors of suicide: A comparison of diagnoses at conscription and in psychiatric care in a cohort of 50 465 young men. *British Journal of Psychiatry*, 157, 339-344.
- Alpert, J. E., Maddocks, A., Rosenbaum, J. F. and Fava, M. (1994). Childhood psychopathology retrospectively assessed among adults with early onset major depression. *Journal of Affective Disorders*, 31(3), 165-171.
- Ameri, A. (1999). The effects of cannabinoids on the brain. *Progress in Neurobiology*, 58(4), 315-348.
- American Psychiatric Association. (2000). *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision*. Washington, DC: American Psychiatric Association.
- Andreasson, S. and Allebeck, P. (1990). Cannabis and mortality among young men: A longitudinal study of Swedish conscripts. *Scandinavian Journal of Social Medicine*, 18, 9-15.
- Andreasson, S., Engstrom, A., Allebeck, P. and Rydberg, U. (1987). Cannabis and schizophrenia: a longitudinal study of Swedish conscripts. *Lancet*, 2, 1483-1486.
- Anthony, J. C. and Helzer, J. E. (1991). Syndromes of drug abuse and dependence. In *Psychiatric Disorders in America: The Epidemiologic Catchment Area*, ed. L. N. Robins and D. A. Regier, pp. 116-54. New York: Free Press.
- Anthony, J. C., Warner, L. A. and Kessler, R. C. (1994). Comparative epidemiology of dependence on tobacco, alcohol, controlled substances and inhalants: basic findings from the National Comorbidity Survey. *Experimental and Clinical Psychopharmacology*, 2(3), 244-268.
- Arseneault, L., Cannon, M., Poulton, R., Murray, R., Caspi, A. and Moffitt, T. E. (2002). Cannabis use in adolescence and risk for adult psychosis: longitudinal prospective study. *British Medical Journal*, 325, 1212-1213.
- Arseneault, L., Moffitt, T. E., Caspi, A., Taylor, P. J. and Silva, P. A. (2000). Mental disorders and violence in total birth cohort: results from the Dunedin study. *Archives of General Psychiatry*, 57, 979-986.
- Australian Institute of Health and Welfare. (1999). *1998 National Drug Strategy Household Survey: First results* (AIHW cat. no. PHE 15). Canberra: AIHW.
- Australian Institute of Health and Welfare. (2002a). *2001 National Drug Strategy Household Survey: First results* (Drug Statistics Series No. 9). Canberra: AIHW.
- Australian Institute of Health and Welfare. (2002b). *2001 National Drug Strategy Household Survey: Detailed findings* (Drug Statistics Series No. 11). Canberra: AIHW.
- Beautrais, A. L. (2000). Risk factors for suicide and attempted suicide among young people. *Australian and New Zealand Journal of Psychiatry*, 34, 420-436.
- Beautrais, A. L., Joyce, P. R. and Mulder, R. T. (1999). Cannabis abuse and serious suicide attempts. *Addiction*, 94(8), 1155-1164.
- Berguis, J., Swift, W., Copeland, J., Roffman, R. A. and Stephens, R. S. (in press). The Teen Cannabis Check-up. In *Cannabis dependence: Its nature, consequences and treatment* (International Research Monographs in the Addictions), ed. R. A. Roffman and R. S. Stephens. London: Cambridge University Press.

- Borges, G., Walters, E. E. and Kessler, R. C. (2000). Associations of substance use, abuse and dependence with subsequent suicidal behaviour. *American Journal of Epidemiology*, 151(8), 781-789.
- Bovasso, G. B. (2001). Cannabis abuse as a risk factor for depressive symptoms. *American Journal of Psychiatry*, 158(12), 2033-2037.
- Burke, B. L., Arkowitz, H. and Menchola, M. (2003). The efficacy of motivational interviewing: A meta-analysis of controlled clinical trials. *Journal of Consulting and Clinical Psychology*, 71, 843-861.
- Chen, C.-Y., Wagner, F. A. and Anthony, J. C. (2002). Marijuana use and the risk of major depressive episode: epidemiological evidence from the United States National Comorbidity Survey. *Social Psychiatry and Psychiatric Epidemiology*, 37, 199-206.
- Chen, K. and Anthony, J. C. (2003). Possible age-associated bias in reporting of clinical features of drug dependence: epidemiological evidence on adolescent-onset marijuana use. *Addiction*, 98, 71-82.
- Chen, K. and Kandel, D. B. (1995). The natural history of drug use from adolescence to the mid-thirties in a general population sample. *American Journal of Public Health*, 85, 41-47.
- Chopra, G. S. and Smith, J. W. (1974). Psychotic reactions following cannabis use in East Indians. *Archives of General Psychiatry*, 30, 24-27.
- Clarke, R. C. and Watson, D. P. (2002). The botany of natural cannabis medicines. In *Cannabis and Cannabinoids: Pharmacology, Toxicology and Therapeutic Potential*, ed. F. Grotenhermen and E. Russo, pp. 3-14. New York: Haworth Press.
- Cleghorn, J. M., Kaplan, R. D., Szechtman, B., Szechtman, H., Brown, G. M. and Franco, S. (1991). Substance abuse and schizophrenia: effect on symptoms but not on neurocognitive function. *Journal of Clinical Psychiatry*, 52(1), 26-30.
- Coffey, C., Carlin, J. B., Degenhardt, L., Lynskey, M., Sanci, L. and Patton, G. C. (2002). Cannabis dependence in young adults: an Australian population study. *Addiction*, 97, 187-194.
- Copeland, J., Swift, W., Clement, N. and Reid, A. (2001). *Young cannabis users' attitudes and beliefs about cannabis and school drug education*. Sydney: New South Wales Department of Education and Training.
- Cross National Collaborative Group. (1992). The changing rate of major depression: cross-national comparisons. *Journal of the American Medical Association*, 268, 3098-3105.
- Cuffel, B. J., Heithoff, K. A. and Lawson, W. (1993). Correlates of patterns of substance abuse among patients with schizophrenia. *Hospital and Community Psychiatry*, 44(3), 247-251.
- Degenhardt, L. and Hall, W. (2001). The association between psychosis and problematical drug use among Australian adults: findings from the National Survey of Mental Health and Well-Being. *Psychological Medicine*, 31(4), 659-668.
- Degenhardt, L., Hall, W. and Lynskey, M. (2001). The relationship between cannabis use, depression and anxiety among Australian adults: findings from the National Survey of Mental Health and Well-Being. *Social Psychiatry and Psychiatric Epidemiology*, 36, 219-227.
- Degenhardt, L. and Hall, W. (2002). Cannabis and psychosis. *Current Psychiatry Reports*, 4, 191-196.
- Degenhardt, L., Hall, W. and Lynskey, M. (2003a). Exploring the association between cannabis use and depression. *Addiction*, 98, 1493-1504.
- Degenhardt, L., Hall, W. and Lynskey, M. (2003b). Testing hypotheses about the relationship between cannabis use and psychosis. *Drug and Alcohol Dependence*, 71, 37-48.
- Degenhardt, L., Lynskey, M. and Hall, W. (2000). Cohort trends in the age of initiation of drug use in Australia. *Australian and New Zealand Journal of Public Health*, 24, 421-426.
- Dennis, M., Babor, T.F., Roebuck, M.C. and Donaldson, J. (2002). Changing the focus: the case for recognizing and treating cannabis use disorders. *Addiction*, 97(Suppl 1), 4-15.

- Der, G., Gupta, S. and Murray, R. M. (1990). Is schizophrenia disappearing? *Lancet*, 335, 513-516.
- Devane, W. A., Hanus, L., Breuer, A., Pertwee, R. G., Stevenson, L. A., Griffin, G., Gibson, D., Mandelbaum, A., Etinger, A. and Mechoulam, R. (1992). Isolation and structure of a brain constituent that binds to the cannabinoid receptor. *Science*, 258, 1946-1949.
- Donnelly, N. and Hall, W. D. (1994). *Patterns of Cannabis Use in Australia*. Canberra: Australian Government Publishing Service.
- Dunn, C., Deroo, L. and Rivara, F. P. (2001). The use of brief interventions adapted from motivational interviewing across behavioural domains: a systematic review. *Addiction*, 96, 1725-1742.
- ElSohly, M. A., Ross, S. A., Mehmedic, Z., Arafat, R., Yi, B. and Banahan, B. F. (2000). Potency trends of delta-9-THC and other cannabinoids in confiscated marijuana from 1980-1997. *Forensic Science*, 45(1), 24-30.
- Fergusson, D. M. and Horwood, L. J. (1997). Early onset cannabis use and psychosocial adjustment in young adults. *Addiction*, 92(3), 279-296.
- Fergusson, D. M. and Horwood, L. J. (2000). Cannabis use and dependence in a New Zealand birth cohort. *New Zealand Medical Journal*, 113, 156-158.
- Fergusson, D. M. and Horwood, L. J. (2001a). Cannabis use and traffic accidents in a birth cohort of young adults. *Accident Analysis and Prevention*, 33(6), 703-711.
- Fergusson, D. M. and Horwood, L. J. (2001b). The Christchurch Health and Development Study: Review of findings on child and adolescent mental health. *Australian and New Zealand Journal of Psychiatry*, 35, 287-296.
- Fergusson, D. M., Horwood, L. J. and Beautrais, A. L. (2003). Cannabis and educational achievement. *Addiction*, 98, 1681-1692.
- Fergusson, D. M., Horwood, L. J. and Swain-Campbell, N. (2002). Cannabis use and psychosocial adjustment in adolescence and young adulthood. *Addiction*, 97, 1123-1135.
- Fergusson, D. M., Horwood, L. J. and Swain-Campbell, N. R. (2003a). Cannabis dependence and psychotic symptoms in young people. *Psychological Medicine*, 33, 15-21.
- Fombonne E. (1995). Depressive disorders: time trends and possible explanatory mechanisms. In *Psychosocial disorders in young people: time trends and their causes*, ed. M. Rutter and D. J. Smith, pp. 616-685. Chichester: John Wiley.
- Gaoni, Y. and Mechoulam, R. (1964). Isolation, structure and partial synthesis of an active constituent of hashish. *Journal of the American Chemical Society*, 86, 1646-1647.
- Goodwin, R. D., Fergusson, D. M. and Horwood, L. J. (2004). Association between anxiety disorders and substance use disorders among young persons: results of a 21-year longitudinal study. *Journal of Psychiatric Research*, 38, 295-304.
- Grant, B. F. (1995). Comorbidity between DSM-IV drug use disorders and major depression: results of a national survey of adults. *Journal of Substance Abuse*, 7(4), 481-497.
- Grant, B. F. and Pickering, R. (1998). The relationship between cannabis use and DSM-IV cannabis abuse and dependence: results from the National Longitudinal Alcohol Epidemiologic Survey. *Journal of Substance Abuse*, 10(3), 255-264.
- Hall, W. (1998). Cannabis use and psychosis. *Drug and Alcohol Review*, 17, 433-444.
- Hall, W. (2004). The psychotogenic effects of cannabis use: challenges in reducing residual uncertainties and communicating the risks. *Addiction*, 99(4), 511.
- Hall, W. and Degenhardt, L. (2000). Cannabis use and psychosis: a review of clinical and epidemiological evidence. *Australian and New Zealand Journal of Psychiatry*, 34(1), 26-34.
- Hall, W., Degenhardt, L. and Lynskey, M. T. (1999). Cohort trends in overdose mortality in Australia 1964-1996: a window on post-war trends in heroin use. *Medical Journal of Australia*, 171, 34-37.

- Hall, W., Degenhardt, L. and Lynskey, M. (2001). *The health and psychological effects of cannabis use*. Canberra: Commonwealth Department of Health and Ageing.
- Hall, W. and Pacula, R. L. (2003). *Cannabis Use and Dependence: Public Health and Public Policy*, Cambridge: Cambridge University Press.
- Hall, W. and Solowij, N. (1998). The adverse effects of cannabis use. *Lancet*, 352, 1611-1616.
- Hall, W. D. and Swift, W. (2000). The THC content of cannabis in Australia: evidence and implications. *Australian and New Zealand Journal of Public Health*, 24(5), 503-508.
- Hartnagel, T. F. (1997). Crime, illegal drug use and social control in the transition from school to work. *Criminal Behaviour & Mental Health*, 7(4), 311-326.
- Hillman, S. D., Silburn, S. R., Green, A. and Zubrick, S. R. (2000). *Youth Suicide in Western Australia Involving Cannabis and Other Drugs: a literature review and research report*. Perth: Western Australian Drug Abuse Strategy Office.
- Hinton, M., Elkins, K., Edwards, J. and Donovan, K. (2002). *Cannabis and psychosis: an early psychosis treatment manual*. Melbourne: Early Psychosis Prevention and Intervention Centre.
- Holden, R. J. and Pakula, I. (1998). Marijuana, stress and suicide: a neuroimmunological explanation. *Australian and New Zealand Journal of Psychiatry*, 32, 465-466.
- Iversen, L. (2000). *The Science of Marijuana*. Oxford: Oxford University Press.
- Jaffe, J. (1985). Drug addiction and drug abuse. In *The Pharmacological Basis of Therapeutics*, ed. A. Gilman, L. Goodman and F. Murad, pp. 532-581. New York: Macmillan.
- Jessor, R., Chase, J. A. and Donovan, J. E. (1980). Psychosocial correlates of marijuana use and problem drinking in a national sample of adolescents. *American Journal of Public Health*, 70(6), 604-613.
- Johnston, L. D., O'Malley, P. M. and Bachman, J. G. (2002a). *Monitoring the Future national survey results on drug use, 1975-2001. Volume I: Secondary school students* (NIH Publication No. 02-5106). Bethesda, MD: National Institute on Drug Abuse.
- Johnston, L. D., O'Malley, P. M. and Bachman, J. G. (2002b). *Monitoring the Future national survey results on adolescent drug use: Overview of key findings, 2001* (NIH Publication No. 02-5105). Bethesda, MD: National Institute on Drug Abuse.
- Johnston, L. D., O'Malley, P. M. and Bachman, J. G. (2003). *Monitoring the Future national survey results on adolescent drug use: Overview of key findings, 2002* (NIH Publication No. 03-5374). Bethesda, MD: National Institute on Drug Abuse.
- Kandel, D. B. and Davies, M. (1992). Progression to regular marijuana involvement: phenomenonology and risk factors for near daily use. In *Vulnerability to drug abuse*, ed. M. Glantz and R. Pickens, pp. 211-253. Washington (DC): American Psychological Association.
- Kandel, D. B., Davies, M., Karus, D. and Yamaguchi, K. (1986). The consequences in young adulthood of adolescent drug involvement: an overview. *Archives of General Psychiatry*, 43, 746-754.
- Kandel, D. B., Yamaguchi, K. and Chen, K. (1992). Stages of progression in drug involvement from adolescence to adulthood: further evidence for the gateway theory. *Journal of Studies on Alcohol*, 53, 447-457.
- Lynskey, M., Degenhardt, L. and Hall, W. (2000). Cohort trends in youth suicide in Australia 1964 to 1997. *Australian and New Zealand Journal of Psychiatry*, 34, 408-412.
- Lynskey, M. and Hall, W. D. (1999). *Cannabis use among Australian youth : prevalence and correlates of use*. Sydney: National Drug and Alcohol Research Centre, University of New South Wales.
- Lynskey, M. and Hall, W. (2000). *Educational outcomes and adolescent cannabis use*. Sydney: New South Wales Department of Education and Training.

- Martin, B. and Cone, E. (1999). Chemistry and pharmacology of cannabis. In *The Health Effects of Cannabis*, ed. H. Kalant, W. Corrigal, W. D. Hall and R. G. Smart, pp. 19-68. Toronto: Centre for Addiction and Mental Health.
- Martin, G., Swift, W. and Copeland, J. (2004). *The adolescent cannabis check-up: a brief intervention for young cannabis users (final report)*. Sydney: National Drug and Alcohol Research Centre, University of New South Wales.
- McCambridge, J. and Strang, J. (2004). The efficacy of single-session motivational interviewing in reducing drug consumption and perceptions of drug-related risk and harm among young people: results from a multi-site cluster randomized trial. *Addiction*, 99, 39-52.
- McGee, R., Williams, S., Poulton, R. and Moffit, T. (2000). A longitudinal study of cannabis use and mental health from adolescence to early adulthood. *Addiction*, 95(4), 491-503.
- McGuire, P. K., Jones, P., Harvey, I., Williams, M., McGuffin, P. and Murray, R. M. (1995). Morbid risk of schizophrenia for relatives of patients with cannabis-associated psychosis. *Schizophrenia Research*, 15, 277-281.
- McIntosh, J., MacDonald, F. and McKeganey, N. (2003). Knowledge and perceptions of illegal drugs in a sample of pre-teenage children. *Drugs: education, prevention and policy*, 10, 331-344.
- Miller, W. R. and Sovereign, R. G. (1989). The check-up: A model for early intervention in addictive behaviors. In: T. Loberg, W. R. Miller, P. E. Nathan & G. A. Marlatt (Eds.), *Addictive behaviours: Prevention and early intervention* (pp. 219-231). Amsterdam: Swets and Zeitlinger.
- Monti, P. M., Colby, S. M. and O'Leary, T. A. (Eds.). *Adolescents, alcohol and substance abuse: Reaching teens through brief interventions*. New York: The Guilford Press.
- Mueser, K. T., Bellack, A. S. and Blanchard, J. J. (1992). Comorbidity of schizophrenia and substance abuse: implications for treatment. *Journal of Consulting and Clinical Psychology*, 60(6), 845-856.
- Mueser, K. T., Drake, R. E. and Wallach, M. A. (1998). Dual diagnosis: a review of etiological theories. *Addictive Behaviors*, 23(6), 717-734.
- Mura, P., Kintz, P., Ludes, B., Gaulier, J. M., Marquet, P., Martin-Dupont, S., Vincent, F., Kaddour, A., Gouille, J. P., Nouveau, J., Moulisma, M., Tilhet-Coartet, S. and Pourrat, O. (2003). Comparison of the prevalence of alcohol, cannabis and other drugs between 900 injured drivers and 900 control subjects: results of a French collaborative study. *Forensic Science International*, 133, 79-85.
- Negrete, J. C., Knapp, W. P., Douglas, D. E. and Smith, W. B. (1986). Cannabis affects the severity of schizophrenic symptoms: results of a clinical survey. *Psychological Medicine*, 16, 515-520.
- Offer, D. and Schonert-Riechl, K. A. (1992). Debunking the myths of adolescence: findings from recent research. *Journal of the American Academy of Child and Adolescent Psychiatry*, 31, 1003-1014.
- Patton, G., Bond, L., Butler, H. and Glover, S. (2003). Changing schools, changing health? Design and implementation of the Gatehouse Project. *Journal of Adolescent Health*, 33, 231-239.
- Patton, G. C., Coffey, C., Carlin, J. B., Degenhardt, L., Lynskey M. and Hall, W. (2002). Cannabis use and mental health in young people: cohort study. *British Medical Journal*, 325, 1195-1198.
- Patton, G. C., Glover, S., Bond, L., Butler, H., Godfrey, C., Di Pietro, G. and Bowes, G. (2000). The Gatehouse Project: a systematic approach to mental health promotion in secondary schools. *Australian and New Zealand Journal of Psychiatry*, 34, 586-593.
- Patton, G. C., Harris, R., Carlin, J. B., Hibbert, M. E., Coffey, C., Schwartz, M. and Bowes, G. (1997). Adolescent suicidal behaviors: a population-based study of risk. *Psychological Medicine*, 27(3), 715-724.
- Pedersen, W., Mastekaasa, A. and Wichstrom, L. (2001). Conduct problems and early cannabis initiation: a longitudinal study of gender differences. *Addiction*, 96, 415-431.

- Perkonig, A., Lieb, R., Hofler, M., Schuster, P., Sonntag, H. and Wittchen, H-U. (1999). Patterns of cannabis use, abuse and dependence over time: incidence, progression and stability in a sample of 1228 adolescents. *Addiction*, 94(11), 1663-1678.
- Poulsen, H. A. and Sutherland, G. J. (2000). The potency of cannabis in New Zealand from 1976 to 1996. *Science and Justice*, 40(3), 171-176.
- Reid, A., Lynskey, M. and Copeland, J. (2000). Cannabis use among Australian adolescents: findings of the 1998 National Drug Strategy Household Survey. *Australian and New Zealand Journal of Public Health*, 24, 596-602.
- Rey, J. M., Sawyer, M. G., Raphael, B., Patton, G. C. and Lynskey, M. (2002). Mental health of teenagers who use cannabis: results of an Australian survey. *British Journal of Psychiatry*, 180, 216-221.
- Rutter, M. (1987). Parental mental disorder as a psychiatric risk factor. In *Psychiatric Update: American Psychiatric Association: Annual Review*, (Volume No. 6), ed. R. Hales and A. Frances, pp. 647-663. Washington: American Psychiatric Press.
- Rutter, M. (1988). Longitudinal data in the study of causal processes: Some uses and some pitfalls. In *Studies of Psychosocial Risk: The Power of Longitudinal Data*, ed. M. Rutter, pp. 1-28. Cambridge: Cambridge University Press.
- Rutter, M. L. (1999). Psychosocial adversity and child psychopathology. *The British Journal of Psychiatry*, 174(6), 480-493.
- Sawyer, M. G., Arney, F. M., Baghurst, P. A., Clark, J. J., Graetz, B. W., Kosky, R. J., Nurcombe, B., Patton, G. C., Prior, M. R., Raphael, B., Rey, J. M., Whaites, L. C. and Zubrick, S. R. (2000). *The Mental Health of Young People in Australia*. Canberra: Mental Health and Special Programs Branch, Commonwealth Department of Health and Aged Care.
- Sawyer, M. G., Arney, F. M., Baghurst, P. A., Clark, J. J., Graetz, B. W., Kosky, R. J., Nurcombe, B., Patton, G. C., Prior, M. R., Raphael, B., Rey, J. M., Whaites, L. C. and Zubrick, S. R. (2001). The mental health of young people in Australia: key findings from the child and adolescent component of the national survey of mental health and well-being. *Australian and New Zealand Journal of Psychiatry*, 35, 806-814.
- Smit, F., Bolier, L. and Cuijpers, P. (2004). Cannabis use and the risk of later schizophrenia: a review. *Addiction*, 99, 425-431.
- Smith, D. E. (1968). Acute and chronic toxicity of marijuana. *Journal of Psychedelic Drugs*, 2, 37-47.
- Smith, D. J. (1995). Youth crime and conduct disorders: trends, patterns and causal explanations. In *Psychosocial disorders in young people: time trends and their causes*, ed. M. Rutter and D. J. Smith, pp. 389-489. Chichester: John Wiley.
- Solowij, N. (1998). *Cannabis and Cognitive Functioning*, Cambridge: Cambridge University Press.
- Stahl, S. M. (1996). *Essential psychopharmacology: neuroscientific basis and clinical applications*. Cambridge: Cambridge University Press.
- Stella, N., Schweitzer, P. and Piomelli, D. (1997). A second endogenous cannabinoid that modulates long-term potentiation. *Nature*, 388, 773-778.
- Swift, W., Hall, W. D. and Copeland, J. (1998a). Characteristics of long-term cannabis users in Sydney, Australia. *European Addiction Research*, 4(4), 190-197.
- Swift, W., Hall, W. D., Didcott, P. and Reilly, D. (1998b). Patterns and correlates of cannabis dependence among long-term users in an Australian rural area, *Addiction*, 93(8), 1149-1160.
- Swift, W., Hall, W. and Teesson, M. (2001a). Cannabis use and dependence among Australian adults: results from the National Survey of Mental Health and Wellbeing. *Addiction*, 96, 737-748.
- Swift, W., Hall, W. D. and Teesson, M. (2001b). Characteristics of DSM-IV and ICD-10 cannabis dependence among Australian adults: results from the National Survey of Mental Health and Wellbeing. *Drug and Alcohol Dependence*, 63(2), 147-153.

- Tart, C. (1970). Marijuana intoxication: common experiences. *Nature*, 226, 701-704.
- Thomas, H. (1993). Psychiatric symptoms in cannabis users. *British Journal of Psychiatry*, 163, 141-149.
- Thomas, H. (1996). A community survey of adverse effects of cannabis use. *Drug and Alcohol Dependence*, 42(3), 201-207.
- Tien, A. Y. and Anthony, J. C. (1990). Epidemiological analysis of alcohol and drug use as risk factors for psychotic experiences. *The Journal of Nervous and Mental Disease*, 178(8), 473-480.
- van Os, J., Bak, M., Hanssen, M., Bijl, R. V., de Graaf, R. and Verdoux, H. (2002). Cannabis use and psychosis: A longitudinal population-based study. *American Journal of Epidemiology*, 156(4): 319-327.
- Velez, C. N., Johnson, J. and Cohen, P. (1989). A longitudinal analysis of selected risk factors for childhood psychopathology. *Journal of the American Academy of Child and Adolescent Psychiatry*, 28(6), 861- 864.
- Verdoux, H., Gindre, C., Sorbara, F., Tournier, M. and Swendsen, J. D. (2003). Effects of cannabis and psychosis vulnerability in daily life: an experience sampling test study. *Psychological Medicine*, 33, 23-32.
- von Sydow, K., Lieb, R., Pfister, H., Hofler, M. and Wittchen, H-U. (2002). What predicts incident use of cannabis and progression to abuse and dependence? A 4-year prospective examination of risk factors in a community sample of adolescents and young adults. *Drug and Alcohol Dependence*, 68, 49-64.
- Weil, A. T. (1970). Adverse reactions to marijuana: classification and suggested treatment. *New England Journal of Medicine*, 282(18), 997-1000.
- Warner, R., Taylor, D., Wright, J., Sloat, A., Springett, G., Arnold, S. and Weinberg, H. (1994) Substance use among the mentally ill: prevalence, reasons for use and effects on illness. *American Journal of Orthopsychiatry*, 64(1), 30-39.
- Wilkins, C., Casswell, S., Bhatta, K. and Pledger, M. (2002). *Drug Use in New Zealand: National Surveys Comparison 1998 and 2001*. Auckland: Alcohol and Public Health Research Unit.
- White, V. (2001). *Australian secondary students' use of over-the-counter and illicit substances in 1999* (National Drug Strategy monograph 46). Canberra: Commonwealth Department of Health and Aged Care.
- White, V. and Hayman, J. (2004) *Australian secondary students' use of over-the-counter and illicit substances in 2002* (National Drug Strategy monograph 56). Canberra: Commonwealth Department of Health and Ageing.
- World Health Organisation. (1993). *The ICD-10 classification of mental and behavioural disorders: diagnostic criteria for research*. Geneva: World Health Organisation.
- Zammit, S., Allebeck, P., Andreasson, S., Lundberg, I. and Lewis, G. (2002). Self reported cannabis use as a risk factor for schizophrenia in Swedish conscripts of 1969: historical cohort study. *British Medical Journal*, 325, 1199-1203.

Appendix 1: A summary of the evidence on the gateway hypothesis and educational outcomes

The gateway hypothesis

Cross-sectional surveys of adolescent drug use in the USA and elsewhere have consistently shown three types of association between cannabis use and the use of other illicit drugs (Morral, McCaffrey and Paddock, 2002), namely, (1) that cannabis use typically precedes the use of other illicit drugs; and that (2) the earlier cannabis is used and (3) the more regularly it is used, the more likely a young person is to use other illicit drugs (Kandel, 2002; Kandel, 1975; Kandel, 1984; Donnelly and Hall, 1994; Donovan and Jessor, 1983; Kandel, 1988; Kandel, 1978). These relationships between cannabis and heroin use have also been reported in longitudinal studies of drug use (Robins, Darvish and Murphy, 1970; Kandel, Davies, Karus and Yamaguchi, 1986; Kandel and Yamaguchi, 2002; Kaplan, Martin and Robbins, 1984; Yamaguchi and Kandel, 1984a; Yamaguchi and Kandel, 1984b; Fergusson and Horwood, 1997; Fergusson and Horwood, 1999; Fergusson and Horwood, 2000; McGee and Feehan, 1993).

The role of cannabis in this sequence (the so called 'gateway pattern' of drug use) remains controversial. There are three major competing explanations of these patterns: (1) that the relationship is due to the fact that there is a shared illicit market for cannabis and other drugs which makes it more likely that other illicit drugs will be used if cannabis is used; (2) that they are explained by the characteristics of those who use cannabis; and (3) that they reflect a causal relationship in which the pharmacological effects of cannabis on brain function increase the likelihood of using other illicit drugs (Hall and Lynskey, 2004).

An evaluation of these explanations by Hall and Lynskey (2004) using the available evidence, indicates that the association reflects in part, but is not wholly explained by: (1) the selective recruitment to heavy cannabis use of persons with pre-existing traits (that may be in part genetic) that predispose to the use of a variety of different drugs; (2) the affiliation of cannabis users with drug using peers in settings that provide more opportunities to use other illicit drugs at an earlier age; (3) supported by socialisation into an illicit drug subculture with favourable attitudes towards the use of other illicit drugs. Animal studies have raised the possibility that regular cannabis use may have pharmacological effects on brain function that increase the likelihood of using other drugs. Further research is required to enable a decision to be made about the relative contributions that social context, individual characteristics and drug effects make to the relationship between cannabis use and the use of other drugs.

Educational outcomes

Source: Lynskey and Hall, 2000

Cross-sectional studies have revealed significant associations between cannabis use and a range of measures of educational performance including lower grade point average, less satisfaction with school, negative attitudes to school, increased rates of school absenteeism and poor school performance (Resnick, Bearman, Blum, Bauman, Harris, Jones, Tabor, Beuhring, Sieving, Shew, Ireland, Bearinger and Udry, 1997; Brook, Brook, De La Rosa, Duque, Rodriguez, Montoya and Whiteman, 1998; Jones and Heaven, 1998). However, results of cross-sectional studies cannot be used to determine whether cannabis use causes poor educational performance, poor educational performance is a cause of cannabis use or whether both outcomes are a reflection of common risk factors. Nonetheless, a number of prospective longitudinal studies have indicated that early cannabis use may significantly increase risks of subsequent poor school performance and, in particular, early school leaving (Fergusson, Lynskey and Horwood, 1996; Fergusson and Horwood, 1997; Brook, Balka and Whiteman, 1999; Ellickson, Bui, Bell and McGuigan, 1998). This association has remained after control for a wide range of prospectively assessed covariates. Although there have been relatively few

studies examining the specific effects of later cannabis use on educational attainment, this conclusion has been supported further by findings that early substance use places young people at heightened risks for reduced educational attainment (Newcomb and Bentler, 1988; Tanner, Davies and O'Grady, 1999; Krohn, Lizotte and Perez, 1997).

Possible mechanisms underlying an association between early cannabis use and educational attainment include the possibility that cannabis use induces an 'amotivational syndrome' or that cannabis use causes cognitive impairment. However, there appears to be relatively little empirical support for these hypotheses. It is proposed that the link between early cannabis use and educational attainment arises because of the social context within which cannabis is used.

In particular, early cannabis use appears to be associated with the adoption of an anti-conventional lifestyle characterised by affiliations with delinquent and substance using peers and the precocious adoption of adult roles including early school leaving, leaving the parental home and early parenthood (see Fergusson and Horwood, 1997). There is some support for this hypothesis as a number of studies have shown that adolescent cannabis use, as well as being associated with early school leaving, is associated with precocious sexual activity (Rosenbaum and Kandel, 1990), unplanned parenthood during adolescence (Mensch and Kandel, 1988; Krohn, Lizotte and Perez, 1997), unemployment (Fergusson and Horwood, 1997) and leaving the family home early (Krohn, Lizotte and Perez, 1997; Fergusson and Horwood, 1997).

Two recent studies have reached similar conclusions. A prospective study of a general population sample of adolescents studied from age 15-21 in Melbourne found that early regular cannabis use (weekly use at age 15) is associated with increased risk of early school-leaving (Lynskey, Coffey, Degenhardt, Carlin and Patton, 2003). A 25-year longitudinal study of a birth cohort of 1265 New Zealand children found that heavier cannabis use was associated with increasing risk of leaving school without qualifications, failure to enter university and failure to obtain a university degree. There was no evidence to suggest that lower educational achievement led to increased cannabis use (Fergusson, Horwood and Beautrais, 2003).

References for Appendix 1

The gateway hypothesis

Donnelly, N. and Hall, W. D. (1994). *Patterns of cannabis use in Australia*. Canberra: Australian Government Publishing Service.

Donovan, J. E. and Jessor, R. (1983). Problem drinking and the dimension of involvement with drugs: A Guttman scalogram analysis of adolescent drug use. *American Journal of Public Health*, 73(5), 543-52.

Fergusson, D. M. and Horwood, L. J. (1997). Early onset cannabis use and psychosocial adjustment in young adults. *Addiction*, 92(3), 279-296.

Fergusson, D. M. and Horwood, L. J. (1999). Prospective childhood predictors of deviant peer affiliations in adolescence. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 40(4), 581-592.

Fergusson, D. M. and Horwood, L. J. (2000). Does cannabis use encourage other forms of illicit drug use? *Addiction*, 95(4), 505-520.

Hall, W. D. and Lynskey, M. (2004). Testing hypotheses about the relationship between cannabis use and the use of other illicit drugs. *Drug and Alcohol Review*, in press.

Kandel, D. (1975). Stages in adolescent involvement in drug use. *Science*, 190, 912-914.

Kandel, D. B. (1978). Convergences in prospective longitudinal surveys of drug use in normal populations. In *Longitudinal research on drug use: empirical findings and methodological issues*, ed. D.B. Kandel, pp. 3-38. New York: John Wiley.

Kandel, D. B. (1984). Marijuana users in young adulthood. *Archives of General Psychiatry*, 41(2), 200-209.

Kandel, D. B. (1988). Issues of sequencing of adolescent drug use and other problem behaviors. *Drugs and Society*, 3(1-2), 55-76.

- Kandel, D. B., ed. (2002). *Stages and pathways of drug involvement: examining the gateway hypothesis*. New York: Cambridge University Press.
- Kandel, D. B., Davies, M., Karus, D. and Yamaguchi, K. (1986). The consequences in young adulthood of adolescent drug involvement: an overview. *Archives of General Psychiatry*, 43(8), 746-754.
- Kandel, D. B. and Yamaguchi, K. (2002). Stages of drug involvement in the U.S. population. In *Stages and pathways of drug involvement: examining the gateway hypothesis*, ed. D. B Kandel, pp. 65-89. New York: Cambridge University Press.
- Kaplan, H. B., Martin, S. S. and Robbins, C. (1984). Pathways to adolescent drug use: self-derogation, peer influence, weakening of social controls and early substance use. *Journal of Health and Social Behaviour*, 25(3), 270-289.
- McGee, R. and Feehan, M. (1993). Cannabis use among New Zealand adolescents. *New Zealand Medical Journal*, 106(961), 345.
- Morral, A. R., McCaffrey, D. F. and Paddock, S. M. (2002). Reassessing the marijuana gateway effect. *Addiction*, 97(12), 1493-1504.
- Robins, L., Darvish, H. S. and Murphy, G. E. (1970). The long-term outcome for adolescent drug users: a follow-up study of 76 users and 146 nonusers. In *The psychopathology of adolescence*, ed. J. Zubin and A.M. Freedman. New York: Grune and Stratton.
- Yamaguchi, K. and Kandel, D. B. (1984a). Patterns of drug use from adolescence to young adulthood: III. Predictors of progression. *American Journal of Public Health*, 74(7), 673-681.
- Yamaguchi, K. and Kandel, D. B. (1984b). Patterns of drug use from adolescence to young adulthood: II. Sequences of progression. *American Journal of Public Health*, 74(7), 668-672.

Educational outcomes

- Brook, J. S., Balka, E. B. and Whiteman, M. (1999). The risks for late adolescence of early adolescent marijuana use. *American Journal of Public Health*, 89, 1549-1554.
- Brook, J. S., Brook, D. W., De La Rosa, M., Duque, L. F., Rodriguez, E., Montoya, I. D. and Whiteman, M. (1998). Pathways to marijuana use among adolescents: cultural/ecological, family, peer and personality influences. *Journal of the American Academy of Child and Adolescent Psychiatry*, 37, 759-766.
- Ellickson, P., Bui, K., Bell, R. and McGuigan, K. A. (1998). Does early drug use increase the risk of dropping out of high school? *Journal of Drug Issues*, 28, 357-380.
- Fergusson, D. M. and Horwood, L. J. (1997). Early onset cannabis use and psychosocial adjustment in young adults. *Addiction*, 92, 279-296.
- Fergusson, D. M., Horwood, L. J. and Beautrais, A. L. (2003). Cannabis and educational achievement. *Addiction*, 98(12), 1681-1692.
- Fergusson, D. M., Lynskey, M. T. and Horwood, L. J. (1996). The short term consequences of early cannabis use. *Journal of Abnormal Child Psychology*, 24, 499-512.
- Jones, S. P. and Heaven, P. C. L. (1998). Psychosocial correlates of adolescent drug-taking behaviour. *Journal of Adolescence*, 21, 127-134.
- Krohn, M. D., Lizotte, A. J. and Perez, C. M. (1997). The interrelationship between substance use and precocious transitions to adult statuses. *Journal of Health and Social Behavior*, 38, 87-103.
- Lynskey, M. T., Coffey, C., Degenhardt, L., Carlin, J. B. and Patton, G. (2003). A longitudinal study of the effects of adolescent cannabis use on high school completion. *Addiction*, 98(5), 685-692.
- Lynskey, M. and Hall, W. (2000). The effects of adolescent cannabis use on educational attainment: a review. *Addiction*, 95(11), 1621-1630.
- Mensch, B. S. and Kandel, D. B. (1988). Dropping out of high school and drug involvement. *Sociology of Education*, 61, 95-113.
- Newcomb, M. D. and Bentler, P.M. (1988). *Consequences of Adolescent Drug Use: impact on the lives of young adults*. Newbury Park, CA: Sage.

- Resnick, M. D., Bearman, P. S., Blum, R. W., Bauman, K. E., Harris, K. M., Jones, J., Tabor, J., Beuhring, T., Sieving, R. E., Shew, M., Ireland, M., Bearinger, L. H. and Udry, J. R. (1997). Protecting adolescents from harm: findings from the National Longitudinal Study on Adolescent Health. *Journal of the American Medical Association*, 278, 823–832.
- Rosenbaum, E. and Kandel, D. B. (1990). Early onset of adolescent sexual behavior and drug involvement. *Journal of Marriage and the Family*, 52, 783–798.
- Tanner, J., Davies, S. and O'Grady, B. (1999). Whatever happened to yesterday's rebels? Longitudinal effects of youth delinquency on education and employment. *Social Problems*, 46, 250–274.

Appendix 2: A definition of cannabis dependence

Cannabis dependence

There is good evidence that cannabis dependence can develop in some chronic cannabis users. These users develop tolerance, experience withdrawal symptoms on cessation of use, have problems controlling their cannabis use and continue to use despite the experience of adverse personal consequences of use.

According to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) (refer p. 197), a diagnosis of substance dependence (including cannabis dependence) is made if *three or more* of the following criteria occur at any time in the same 12-month period:

- “1. tolerance, as defined by either of the following:
 - a. a need for markedly increased amounts of the substance to achieve intoxication or desired effect
 - b. markedly diminished effect with continued use of the same amount of the substance
2. withdrawal, as manifested by either of the following:
 - a. the characteristic withdrawal syndrome for the substance
 - b. the same (or closely related) substance is taken to relieve or avoid withdrawal symptoms
3. the substance is often taken in larger amounts or over a longer period than was intended;
4. there is a persistent desire or unsuccessful efforts to cut down or control substance use;
5. a great deal of time is spent in activities necessary to obtain the substance (e.g. visiting multiple doctors or driving long distances), use the substance (e.g. chain-smoking), or recover from its effects;
6. important social, occupational, or recreational activities are given up or reduced because of substance use;
7. the substance use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by the substance”.

Reference for Appendix 2

American Psychiatric Association. (2000). *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition, Text Revision. Washington, DC: American Psychiatric Association.

ISBN 073138390-7



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